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Pesticide Risk Reduction in California Prunes
Final Report 1999-2001

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II. Disclaimer

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II. Table of Contents

III. Executive Summary

Due to the impending loss of many pesticides, stricter use regulations, and concerns over contaminating natural resources, this project was begun to develop, research, demonstrate, and implement alternative practices that reduce pesticide use and conserve natural resources.

The core Integrated Prune Farming Practices (IPFP) project revolves around monitoring and developing treatment thresholds for pests, plant nutrition, and irrigation needs. Pests being studied include: European red and web-spinning mites, san jose scale, european fruit lecanium, prune aphids, peach twig borer, leaf-rollers, prune rust, and fruit brown rot.

Results from the past three years' pest monitoring and applying pesticide treatments only when a pest reaches treatment threshold indicated by using monitoring/treatment threshold data being developed in this project, approximately 1,957,566 pounds a.i. of pesticides and their application could have been saved in 2001, approximately 869,840 pounds a.i. of pesticides and their application could have been saved in 2000 and approximately 1,723,910 pounds a.i. of pesticides and their application could have been saved in 1999. . The savings would have been mostly from unneeded prune rust treatments with a minor amount from unneeded dormant insecticide and oil treatments.

Tree water status monitoring indicated that many growers in the program are applying more water than needed for best production; savings could be occur when tree water needs are monitored and irrigation's applied only as needed. Estimates of savings appear to be around 40 percent when compared to current conventional irrigation scheduling practices.

Some grower/cooperators had well water with high levels of nitrate nitrogen, which would be utilized by the tree. This available nitrogen source was taken into account when fertilizer recommendations were made.

Over 53 educational meetings, which discussed progress and implementation of the data being developed, were held in from 1999 to 2001, for an audience of over 2680 individuals interested in prune production. Many newsletters were published and widely distributed about the progress of the project. Electronic media was used in at least two counties to advise prune growers of pest status and "reduced risk" treatment options.

In 1999 Pest Control Advisors (PCA's) began evaluating the monitoring techniques used in this project. The PCA's generally agreed with the treatment thresholds but felt that many of the monitoring techniques took too long. Efforts were made to streamline the monitoring techniques for wider acceptance.

IV. Accomplishments

PROBLEM AND ITS SIGNIFICANCE

Economics and regulations are creating change in the way prunes are farmed. Cost of farming is going up, the industry is experiencing problems with over production and the industry will no longer pay for small, poor quality fruit. Federal acts, such as the Federal Clean Air Act, Federal Food Quality Protection Act and California's Proposition 65 and 204 dealing with water quality, establish expiration dates and/or threaten continued use of many pesticides. Regulations established by California Department of Pesticide Regulation (DPR) have created new requirements and certification for application of pesticides. Misuse of natural resources is becoming a common environmental concern.

Alternative, low environmental risk practices, to the conventional way prunes have been farmed, need to be researched and results demonstrated and implemented to adjust to current economics and approaching and/or existing regulations. Economic thresholds and monitoring techniques need to be discovered so that pesticide use can be safely reduced, or at least used in a timely fashion when needed. Water conservation that does not interfere with prune production needs to be researched and demonstrated

Integrated Prune Farming Practices (IPFP) is a research/implementation project that includes 7 University of California (U.C.) prune farm advisors, 1 U.C. IPM advisor, 3 U.C. faculty members and one U.C. specialist to advance economically and environmentally sound approaches to prune production. The overall project was begun in 1998 with support from the California Prune Board.

Project objectives include:
I Develop economic thresholds, monitoring techniques, and implement alternative pest control strategies that reduce use of conventional biocides
II Encourage more effective use of fertilizers and natural resources.
III Encourage known useful cultural operations into a more sustainable farming system.

The objective is to compare cultural practices dealing with pest management, fertilization and irrigation between the conventional and more sustainable or "reduced-risk" approach to growing prunes. Reduced-risk means a reduced risk to the environment without additional risk to the grower. After a few years of establishing these comparisons, an economic comparison will also take place.

PROJECT INFRASTRUCURE:

The project was conducted in Tulare, Madera, Fresno, Yolo, Sutter, Yuba, Butte, Glenn and Tehama counties. Research and Implementation Orchards compared two prune-farming systems to an untreated check: 1) conventional system and 2) a "reduced-risk" system. Each system consists of at least 5 acres. The conventional system consisted of the grower's normal practices, but included an Asana and oil dormant spray. Pest control for the reduced-risk system was based on monitoring protocols developed for this project. A small-untreated "check" area was also present at each site to help validate the two prune farming systems. Currently the project is being conducted on individual prune farms ranging from Tulare to Tehama County, twenty-three sites total. Those 23 sites were chosen, based on their location, to best represent the prune industry in California. In addition to the 23 sites there are also 8 sites that were monitored by pest control advisors.

Monitoring: The pests monitored included: san jose scale, european fruit lecanium, european red mite eggs, prune aphids, peach twig borer, the leaf roller complex, beneficial insects, prune rust, fruit brown rot, and spider mites. In addition, tree nutrient status and water status were monitored. Tree water status was used for irrigation scheduling purposes.

Field assistants (scouts) monitored each site. There were nine scouts assigned to the project. Monitoring data results in recommendations for the grower-cooperators about pest control, fertilization and irrigation scheduling. The cooperator agrees to apply these recommendations to the reduced-risk segment of the orchard. In many cases irrigation schedules could not be applied separately to the conventional and reduced-risk plots. In these cases our irrigation recommendations were applied in the entire plot. As new monitoring techniques and recommendations become available they will be incorporated into the project. These techniques and recommendations will, most likely, come from the satellite projects described earlier and reported on separately.

Implementation orchards were orchards that had converted totally to a "reduced risk" status. Pest control, fertilizer, and irrigation scheduling recommendations were based on field monitoring at each of the demonstration sites.

Evaluation: Evaluation of these two farming systems was carried out using data collected throughout each season and final plot evaluations just prior to harvest. Additionally, these systems were evaluated based on DFA grade sheets and dry-away information provided by the participating farm advisors in 2001 and P-1 grade sheets from growers in 1999 and 2000.

Education/outreach: The project required each farm advisor to conduct at least one educational meeting each year focusing on reduced risk practices emanating from the IPFP project. Farm advisors were also encouraged to write newsletters and other popular articles about the IPFP project Insect day-degree accumulation equipment was used to calculate day-degrees from the biofix for various pests. E-mail and web site communication between advisors and clientele, regarding pest monitoring, day-degree accumulation and field observations were encouraged.

Funding: It is recognized that the California Prune Board cannot support this project to the extent needed to attract rapid, wide adoption of reduced risk practices by clientele. To this end, additional grant support from other agencies is being sought to expand the project beyond the capabilities of the California Prune Board. However, securing other grant funding is contingent upon prune industry support provided by the California Prune Board.

Satellite projects: Projects need to be researched before being demonstrated or adopted on a wide scale. "Satellite projects" to evaluate single aspects of reduced risk may be established in one or more areas. These satellite projects are "stand alone" projects. Their objectives are designed to address single researchable questions within IPFP. For example, evaluating aphid control with soft chemicals. Reduced risk satellite projects will be reported separately by those involved. In previous years, this project supported research on:

1) An alternate year dormant spray program to cut pesticide use in half
2) A predictive model for forecasting scab off-grade at harvest,
3) Aphid control using soft chemicals
4) A "mow and throw" technique for weed control by either using cover crop residue following mowing or rice straw (ag-waste) as mulch for weed control down the tree row.

In 2001, the project supported research on:

1) Controlling mealy plum and leaf curl plum aphids using reduced rates of Diazinon and Asana with oil, in a dormant spray.
2) Controlling mealy plum and leaf curl plum aphids by using zinc to induce early fall defoliation.
3) Using pheromone traps to predict OBLR populations and fruit damage.
4) Literature and research review of prune aphid control using oils over the past ten years.
5) A project using water traps to catch fall returning aphids to determine exactly when they return to lay their over-wintering eggs has begun.

In 2000, the project supported research on:

1) Biological control of Mealy Plum Aphids using *Harmonia axyridis* lady beetles.
2) Pesticide efficacy trial using 2 types of oil and 1 type of pesticide for aphid control.
3) Alternate year dormant insecticide program evaluation.
4) A new aphid infestation-predicting model.

In 1999, material efficacy trials were conducted for control of prune aphids using soft materials including a number of novel products not yet registered.

I. Develop economic thresholds, monitoring techniques and implement alternative pest control strategies that reduce use of conventional biocides

1. Dormant Treatment Decision Guide

Situation: Prune growers have had no way of knowing if they need to apply a dormant insecticide and oil spray. The dormant spray has been in wide use because growers have been taught for many years that this is the most efficacious spray they can apply. It: 1) kills a number of pest including San Jose Scale (SJS), peach twig borer (PTB), European Red Mite (ERM), mealy plum aphid and leaf curl plum aphid, and 2) is least harmful to beneficials. Also many prune growers apply a dormant spray because there is no good reduced risk alternative to high populations of prune aphids. Recently the dormant spray has been implicated in polluting natural resources. These findings suggested that the dormant insecticide spray is being over used. A monitoring technique was needed to help growers decide if they required a dormant insecticide treatment.

Evaluation:

A fall aphid monitoring technique, orchard history evaluation of aphids and a dormant fruit spur monitoring technique were developed to see if these techniques would be useful in making dormant treatment decisions for prune aphids, SJS and EFL. Since the project began, fall aphid monitoring data was correlated to spring aphid monitoring data to try and develop a model that could be used to predict the level of aphid infestation that would occur in spring, based on fall aphid counts. After 3 years of monitoring and comparing data, a correlation of only 46% (Significant at the 99% Level) was the best that could be achieved (Fig. 1A). However, the fall aphid monitoring technique proved to be 80% accurate (Significant at the 99% level) in predicting whether or not orchards will have aphids in the spring. In order to try and make the model more accurate, Tim Prather, an IPM Advisor, to see if he could think of ways to improve upon it, reviewed data. Tim came up with a model that is referred to as the Prather Aphid Predicting Model or "Prather Model" for short. This new model tried to account for the aphids flying to and from their alternate hosts in the late summer/early fall and considered geographic regions. It also assumed that if an orchard had a high population of aphids in the spring, the grower would spray for them and there would be less of a population that could return in the fall resulting in fewer aphids the following spring. The Prather Model did not have a significant correlation between predicted percent of trees to have aphids in the spring and the actual percent of trees to have aphids, with only 7 percent (Fig. 1B). In 2000, spring aphid counts in 1999 were compared to spring aphid counts in 2000 and found that there was a 76% accuracy (Significant at the 99% level) in predicting level of aphid infestation. Based on the finding of previous years two treatment guides were developed in 2001. For orchards that had been receiving annual dormant insecticide sprays, treatment threshold is reached if: 1) one tree out of 40 trees monitored in fall has prune aphids; or 2) orchard history indicates at least one tree had aphids last season despite application of a dormant insecticide and oil; or 3) at least one aphid egg is found in the dormant spur sample. For orchards that have not been receiving dormant insecticide sprays, treatment threshold is based on orchard history. If 10% or more of the trees had aphids during the last growing season, then treatment threshold has been reached.

The sequential sampling dormant spur monitoring technique involved sampling spurs in winter for the presence of SJS or EFL crawlers and is the other part of the "Dormant Treatment Decision Guide". One hundred spurs are collected and 20 of them at a time are evaluated for presence of SJS and EFL. If, after evaluating the 20 spurs, a decision cannot be made, another 20 were evaluated and so on until all one hundred have been evaluated. In most cases the decision could be made after only looking at the first 20 spurs. The sequential sampling treatment threshold was based on 10 % of the spurs out of 100 having live scale (see Tables 1 & 2.).

Figure 1A.

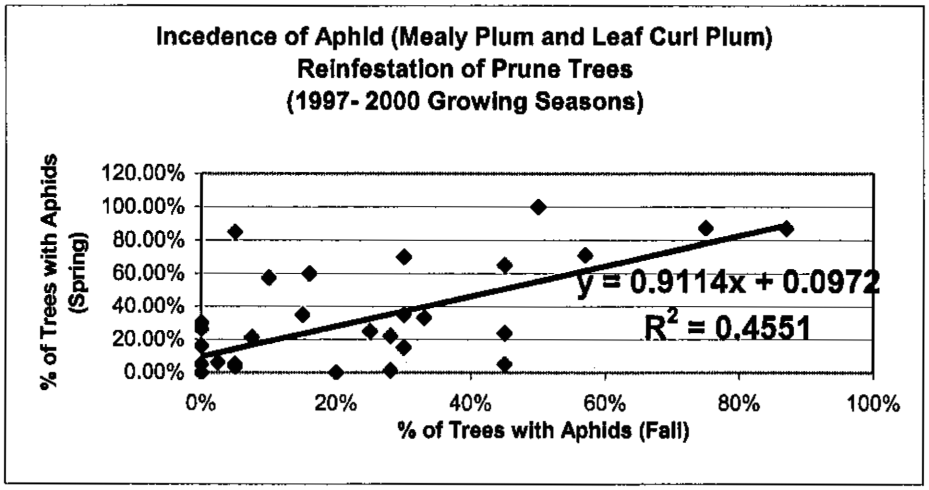


Fig1B. Prather Model

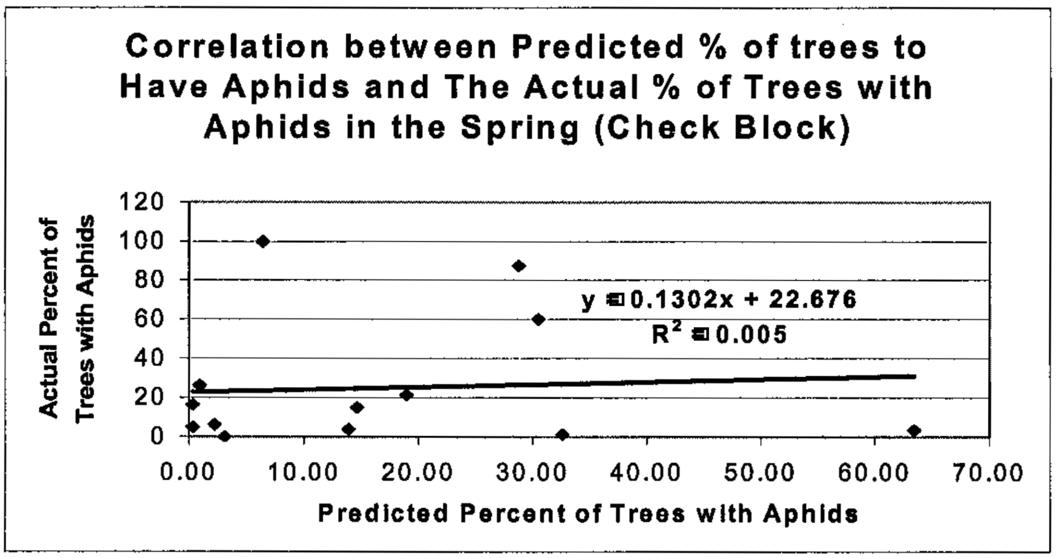


Table 1.

Dormant Treatment Guide For Orchards That Have been Receiving Dormant Insecticide Sprays in The Past

Aphids present using methods 1, 2 or 3 (Y,N)	Scale above Threshold	Reduced Risk Treatment Reccomendation	Conventional Treatment Recommendation
N	N	Nothing	Nothing
N	Y	Dormant Oil	Dormant Insecticide + Oil
Y	N	Oil at Green Tip or Growing season Insecticide or Growing season Oil*	Dormant Insecticide + Oil
Y	Y		Dormant Insecticide + Oil

* Oil alone is not effective for Leaf Curl Plum Aphid once the leaves are

1) One tree out of the 40 trees monitored in the fall has prune aphids.

2) Orchard history indicates at least one tree had aphids last season

3) One or more aphid eggs are found in the dormant spur samples.

Table 2.

Dormant Treatment Guide for Orchards That Have Not been Receiving Dormant Insecticide Sprays in The Past				
Orchard History Indicates:		**Scale above Threshold**	**Reduced Risk Treatment Recomendation**	**Conventional Treatment Recommendation**
Below 10% of Trees Infested w/aphids	**Above 10% of Trees Infested w/aphids**			
x		N	Nothing	Nothing
x		Y	Dormant Oil	Dormant Insecticide + Oil
	x	N	Oil at Green Tip or Growing season Insecticide or Growing season Oil*	Dormant Insecticide + Oil
	x	Y		Dormant Insecticide + Oil
*Oil alone is not effective for Leaf Curl Plum Aphid once the leaves are curled.				

Results: The "Dormant Treatment Decision Guide" developed in 2001 accurately predicted, in every case, whether or not an orchard needed to be treated for MPA, LCPA, SJS and/or EFL. One site was predicted to have a LCPA problem was treated with a reduced risk treatment of oil 4 weeks after green tip with no success.

By using these guides in 2001 we found that 78.26% of the project orchards did not have an aphid problem and did not need a dormant insecticide and/or oil treatment for aphids while 21.74 % were predicted to have aphids and required a treatment of some kind (Fig 1C).

SJS populations in project orchards were found to be at treatable levels in 17.4 % of the project orchards (Fig. 2). Overall 60.87 % of the orchards did not need to apply a dormant insecticide for either scale or aphids (Fig. 3).

As the distribution of project orchards was intended to represent the California prune industry, not treating 60.78 percent of the bearing prune orchards with a dormant insecticide and oil spray would result in a reduction of 156,812 lbs a.i. of pesticide (based on all bearing acreage receiving a dormant spray of Diazinon at the recommended label rate).

Conclusions: Clearly a "Dormant Treatment Decision Guide" such as the one evaluated was very useful in making dormant treatment decisions in 2001. Further evaluations of this guide will be conducted next year.

Over the next few years, surveys of growers will be conducted to determine the extent of implementation of the "Dormant Treatment Decision Guide."

Fig. 1C

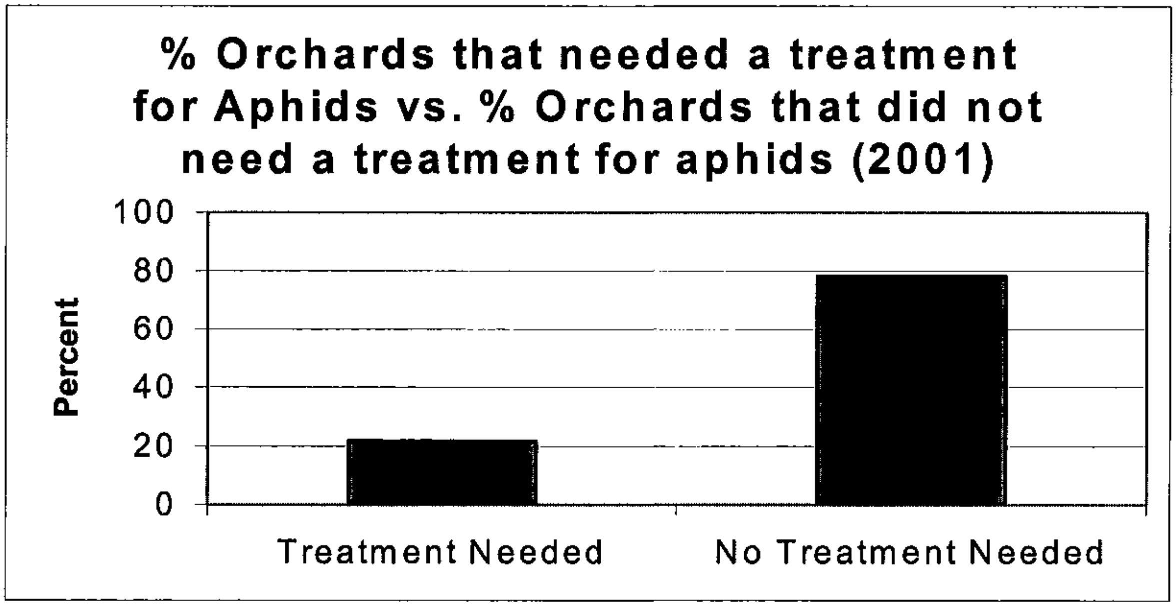

% Orchards that needed a treatment for Aphids vs. % Orchards that did not need a treatment for aphids (2001)
Percent
100
80
60
40
20
0
Treatment Needed
No Treatment Needed

Fig 2.

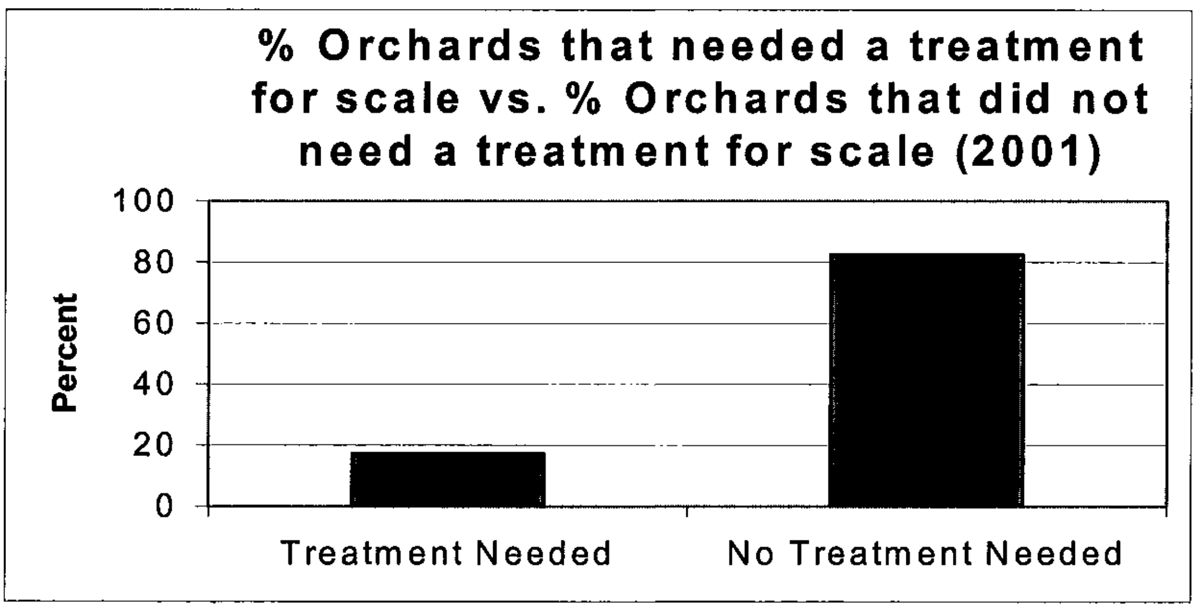
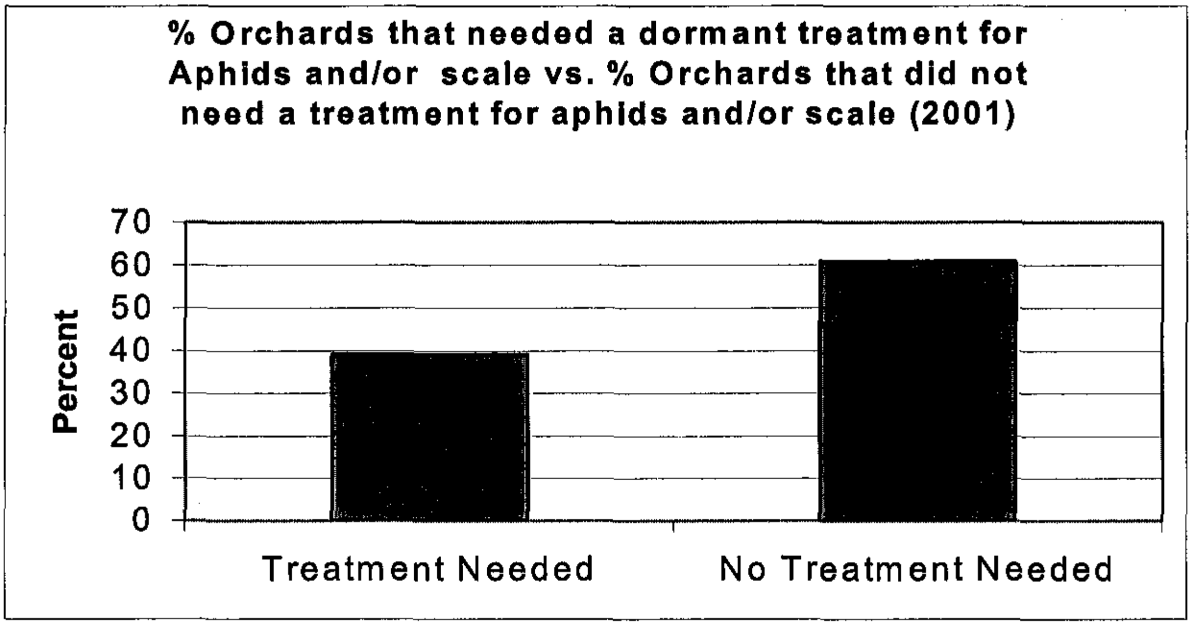

% Orchards that needed a treatment for scale vs. % Orchards that did not need a treatment for scale (2001)
Percent
100
80
60
40
20
0
Treatment Needed
No Treatment Needed

Fig 3.



2. Pheromone Traps to Aid with Treatment Decisions

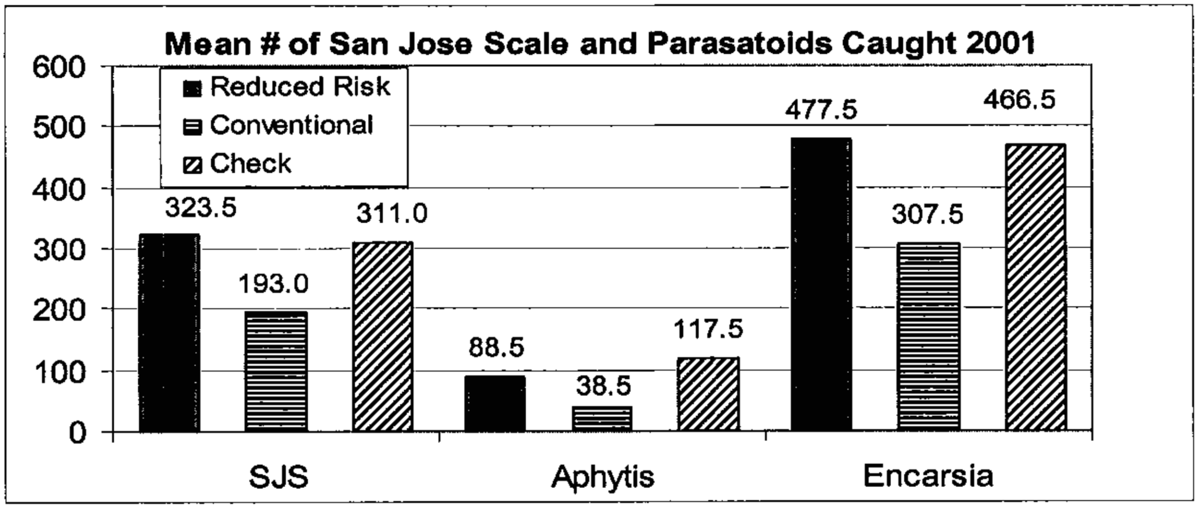
Situation: Pheromone traps have long been available but are generally underutilized by prune growers making treatment decisions. They, most commonly, are used to help determine treatment timing and, in the case of SJS traps, are also be used to access the presence of beneficial insects. Rarely have they been shown to be useful or have they been used to help determine if a treatment is needed. Information of this type could be useful to prune growers who may need to treat for PTB, OBLR or SJS.

A. San Jose Scale

Evaluation: By monitoring SJS pheromone traps in spring, the quantity of beneficial insects, as well as, SJS males was documented in each orchard each year since 1999. For each site, 1000 fruit were examined per plot in July and near harvest for evidence of SJS crawlers.

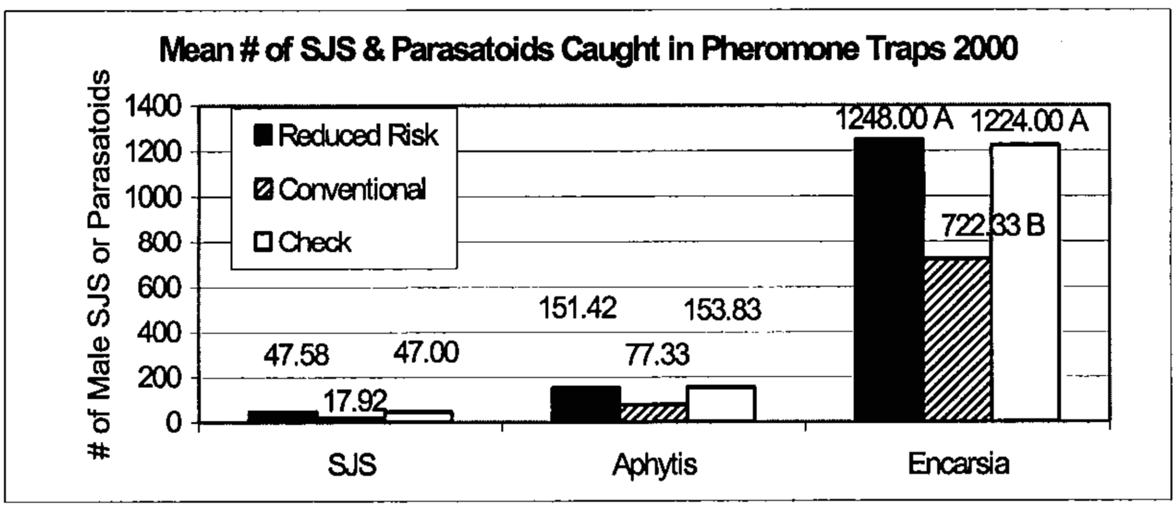
Results: No significant differences in pheromone trap catches were found for male SJS between the conventional, reduced-risk, and check plots in all three years (Figs 4 - 6). Significant differences in beneficial insects did occur. *Encarsia (Prospatella)* was caught in significantly larger numbers in reduced risk and check plots than in conventional plots in 2001 (Fig 4). No live or parasitized San Jose Scale was found on fruit during pre-harvest fruit evaluation in 2001(Table 4). However, some live SJS was found on fruit in the 2000 and 1999 crops (Tables 5 and 6).

Fig4.



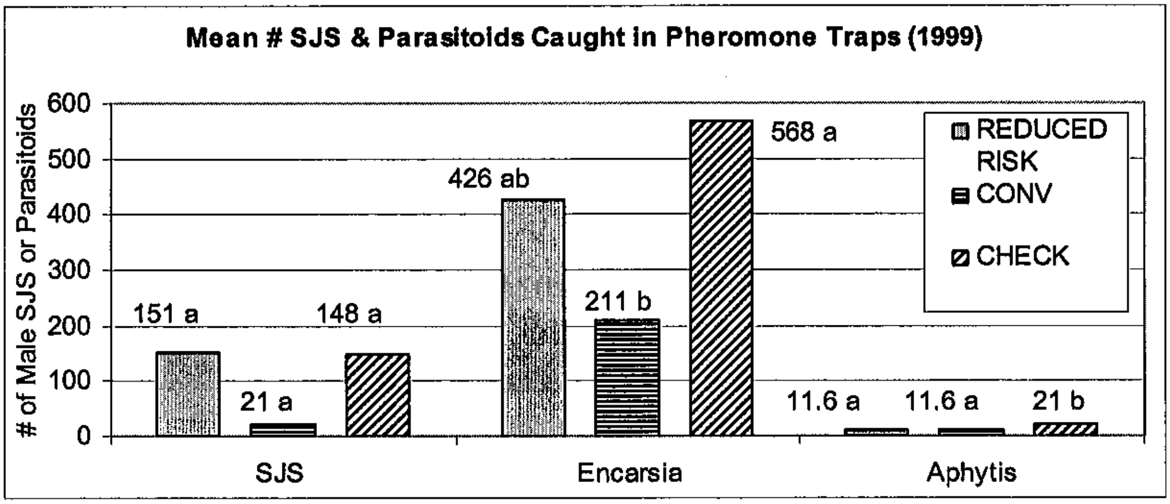
Ns Ns Ns

Fig5.



Treatment means not followed by a common letter are significantly different from each other at the 95% confidence level according to Duncan's Multiple Range Test for Mean Separation.

Fig6.



Treatment means not followed by a common letter are significantly different from each other at the 95% confidence level according to Duncan's Multiple Range Test for Mean Separation.

Table 4. Mean % Fruit w/ SJS or Parasitized SJS Present at Harvest (2001)

TREATMENT	% Fruit w/ SJS*	% Fruit w/ Parasitized Scale*
REDUCED RISK	0	0
CONVENTIONAL	0	0
CHECK	0	0
	Ns	Ns

Table 5. Mean % Fruit w/ SJS or Parasitized SJS Present at Harvest (2000)

TREATMENT	% Fruit w/ SJS	% Fruit w/ Parasitized Scale
REDUCED RISK	.01 ab	0.03
CONVENTIONAL	.03 a	0
CHECK	0 b	0.02

Treatment means not followed by a common letter are significantly different from each other at the 95% confidence level according to Duncan's Multiple Range Test for Mean Separation.

Table 6. Mean % Fruit w/ SJS or Parasitized SJS Present at Harvest (1999)

TREATMENT	% Fruit w/ SJS	% Fruit w/ Parasitized Scale
REDUCED RISK	1.1 ab	.01
CONVENTIONAL	.25 b	0
CHECK	2.01 a	0

Treatment means not followed by a common letter are significantly different from each other at the

95% confidence level according to Duncan's Multiple Range Test for Mean Separation.

Conclusion: Presence of more parasitoids in reduced risk and check plots, where dormant insecticides had not been applied for 3 or more years, indicates the dormant insecticide and oil treatment reduced populations of these beneficial insects. SJS traps gave a good indication of scale and scale parasites in the orchard. 1999 was the worst of the three years for SJS damage. However, there was no significant difference between the reduced risk plots and conventional plots. One of the main reasons no significant difference occurred was an oil application alone can be used to control SJS the dormant and delayed-dormant periods.

B. Peach twig borer (PTB)

Situation: In previous years, research correlating PTB pheromone trap catches with damaged fruit at harvest was conducted. Results found a correlation ranging from 60 to 80 percent. However, even though this technique looked promising, PCA's and growers said that they would not use it. Besides comparing trap catches to damage at harvest, live PTB larva and PTB damage during the season were also evaluated. A very high correlation was the result of the comparison. However, no PCA or grower would monitor 80 trees per orchard every week; it would be to costly and time consuming.

Evaluation: Currently PCA's and growers use PTB pheromone traps to obtain a biofix and then base their sprays on degree-day accumulation. So this year (2001), using previous research data, we evaluated a one-time fruit monitoring technique that a PCA or grower would be more inclined to use. PTB pheromone traps were used to obtain a biofix. 400 day-degrees after biofix 1200 fruit were evaluated in each plot for presence of PTB larva or damage. Based on this fruit evaluation, a treatment decision could be made based on a threshold of 1 % of fruit having larva and/or larva damage. The 1% threshold was chosen based on an average crop of 2.5 ton per acre and a price of $800/ton; this would equal the cost of an insecticide spray. By applying an insecticide spray for worms you would lessen chances of more worm damage and onset of brown rot. However, if the orchard history indicated that last year's crop had significant worm damage then, two-bloom time *B.t.* sprays (one at "popcorn" and again ten days later) were recommended. For each site, 1000 fruit were examined per plot in July and near harvest for evidence of PTB larvae or damage.

Results: In 2001, the fruit evaluation at 400 day-degrees after biofix found none of the project orchards needed a growing season PTB treatment based on the treatment threshold for dried plums, 1%. The July sample found only one orchard had PTB larva and/or damage over 1 % with 1.3 % damage. At harvest only one orchard, a different one had PTB larva and/or damage of over 1 % with 1.4 % damage. There was no significant difference in PTB damaged fruit between the conventional and reduced risk plots at harvest (Table 7.) Based on previous orchard history of having over 4 % of the fruit damaged due to PTB larvae, one orchard received two bloom-time B.t. sprays (one at popcorn and again ten days later). The same orchard also received a growing season insecticide even though the orchard did not exceed the treatment threshold for dried plums. The grower applied the treatment based on the assumption that he was going to sell some fruit to the fresh market and he wanted as little worm damage as possible. Based on the 400 degree-day fruit evaluation that revealed 2.29 % PTB damage in the untreated area, a spray was suggested. This strategy was successful compared to PTB damage found in the check (Table 8).

Table 7. Mean % Fruit with PTB Damage Present 2001

Treatment	400 Degree-Days	July PTB Damage	Harvest PTB Damage	DFA Disease/Insect Offgrade
Reduced Risk	0.1	0.7	0.4	0.6
Conventional	0.0	0.6	0.3	0.5
CHECK*	0.1	0.7	0.4	0.5

nsns ns ns

* Reduced Risk and the Check plots were both untreated; therefore reduced risk plot data was used The only reduced risk plot that received a treatment for PTB in 2001is shown separately in Table 8.

Table 8.

% Fruit with PTB Damage (Butte County Orchard) 2001			
	Bt + Inseason Insecticide + Monitoring	Dormant Insecticide + Inseason Insecticide + Monitoring	Untreated Check
400 Degree-Days	0.8	0.3	2.9
July Evaluation	0.2	0.0	1.8
Harvest Evaluation	0.7	1.4	2.3
DFA Disease/Insect Offgrade	0	0	1.3

nsnsns

Conclusion: Fruit monitoring based on a PTB biofix using pheromone traps was a useful tool in determining treatment necessity and timing in 2001. However, more research on this method will need to be conducted. A 1% treatment threshold may be correct based on the fact that at harvest, DFA found very low levels of worm damage in the fruit when the 400 degree-day evaluation was below 1% (Table 7), but found, when there was more than 1% worm damage in the dried fruit, levels were also above 1% at 400 degree-days (Table 8). The block that had worm damage above 1% at 400 degree-days was an untreated check.

Over the next few years, surveys of growers will be conducted to determine the extent, if any, of implementation of the fruit sampling at 400-degree days technique?

<u>C. Oblique Banded Leaf Roller (OBLR):</u>

Demonstration: Research using OBLR trap catches and fruit monitoring was conducted and evaluated in previous years (1999-2000) just as the PTB research described above. However, this year (2001) a one-time sample could not be tested because exact degree-days for OBLR in prunes were not known. Starting at 690 degree-days (degree days recommended on other crops) weekly fruit monitoring was conducted for 3 weeks (to determine best evaluation timing) in each plot for the presence of OBLR larva or damage. Based on fruit evaluation a treatment decision could be made. However, if the orchard history indicated that last year's crop had significant worm damage then, two-bloom time *B.t.* sprays (one at popcorn and again ten days later) were recommended. For each site, 1000 fruit were examined per plot in July and near harvest for evidence of OBLR larvae or damage.

Results: Weekly fruit evaluation, beginning 690 day-degrees after biofix, found that none of the project orchards needed to apply a growing season OBLR treatment. The treatment threshold for dried plums is 1% of the 1200 fruit sampled for 3 weeks starting at 690 degree-days having OBLR larva and/or OBLR damage. The 1% threshold was chosen based on an average crop of 2.5 ton per acre and a price of $800/ton would equal the cost of an insecticide spray. By applying an insecticide spray for worms you would lessen the chances of more worm damage and the onset of brown rot. The July sample found six orchards had OBLR larva and/or damage over 1 % with 2.5 % being the highest. At harvest five orchards had OBLR larva and/or damage of over 1 % with 2.5 % being the highest. There was no significant difference between the conventional and reduced risk plots in the amount of OBLR damaged fruit found at harvest (Table 9.)

Table 9. Mean % Fruit with OBLR Damage Present (690 Degree-Days + 2 weeks, July and Harvest Final Evaluations) 2001

Treatment	690 Degree-Days + 2 weeks*	July OBLR Damage*	Harvest OBLR Damage*
Reduced Risk	0.5	0.9	0.8
Conventional	0.5	0.4	0.7
CHECK	0.5	0.9	0.8

nsnsns

Conclusion: Fruit monitoring based on an OBLR biofix, using pheromone traps can be a useful tool in determining treatment necessity and timing. However, more research on this method will need to be conducted.

3. Spring Prune Aphid Monitoring

Situation: Without a dormant insecticide and oil treatment it will be important to assess aphid populations in in-season to determine if treatments are needed.

-Evaluation: Beginning in April, a random sample of 80 trees per plot was observed weekly to determine presence of leaf curl plum aphids (LCPA) and mealy plum aphids (MPA) (1999-2000). The treatment threshold was 10 percent or more of the trees having aphids. In 2001, the treatment threshold was changed based research done by Dr. Nick Mills, U.C. Berkley. If more than 20 percent of the trees were significantly infested (aphids covering 10% of tree surface or more), then

treatment was recommended. Recommendations ranged from an oil treatment to suppress MPA, to an insecticide treatment to eliminate MPA or LCPA.

In 2001, a statistician developed a sequential sampling technique for prune aphids from previous year's data. Sequential sampling allows for a small number of trees (20) to be sampled. From this small sample if a decision to treat is predicted, then sampling can stop. If MPA and/or LCPA aphid levels are determined to be very low, sampling can also stop. If MPA and/or LCPA levels are moderate (more than very low, but not enough to call for a treatment) then additional trees (10) need to be sampled. Continued sampling an additional 10 trees is needed until a decision can be made or 80 trees have been sampled.

Results: After following the dormant treatment recommendation based on the "Reduced Risk Dormant Treatment Decision Guide" one orchard out of 23 exceeded the treatment threshold for leaf curl plum aphid during the growing season. This orchard was accurately predicted to have an aphid problem, but the reduced risk oil treatment was applied too late to be effective. None of the orchards that followed the treatment recommendation exceeded the threshold for MPA during the growing season. However, one orchard that did not follow the treatment recommendation did exceed the treatment threshold for MPA.

The sequential sampling technique was compared to the conventional sampling method of looking at all 80 trees and produced the same results as the conventional technique.

During the final evaluations, 40 fruit (from up to 25 trees) were examined from trees, which had been infested by MPA, and 40 fruit (from up to 25 trees) were examined from trees that had not been infested by MPA. Example: if only 10 trees in the orchard had aphids, then only 10 trees that did not have aphids would be evaluated. Trees with MPA present did not have significantly higher levels of side cracks, end cracks or total cracks present on fruit than trees without aphids in 2001 (Fig 7). However, in 2000 trees with aphids did have significantly more end and side fruit cracking (Figs 8 and 9).

Fig7. Mean % Fruit Cracking due to Mealy Plum Aphids 2001

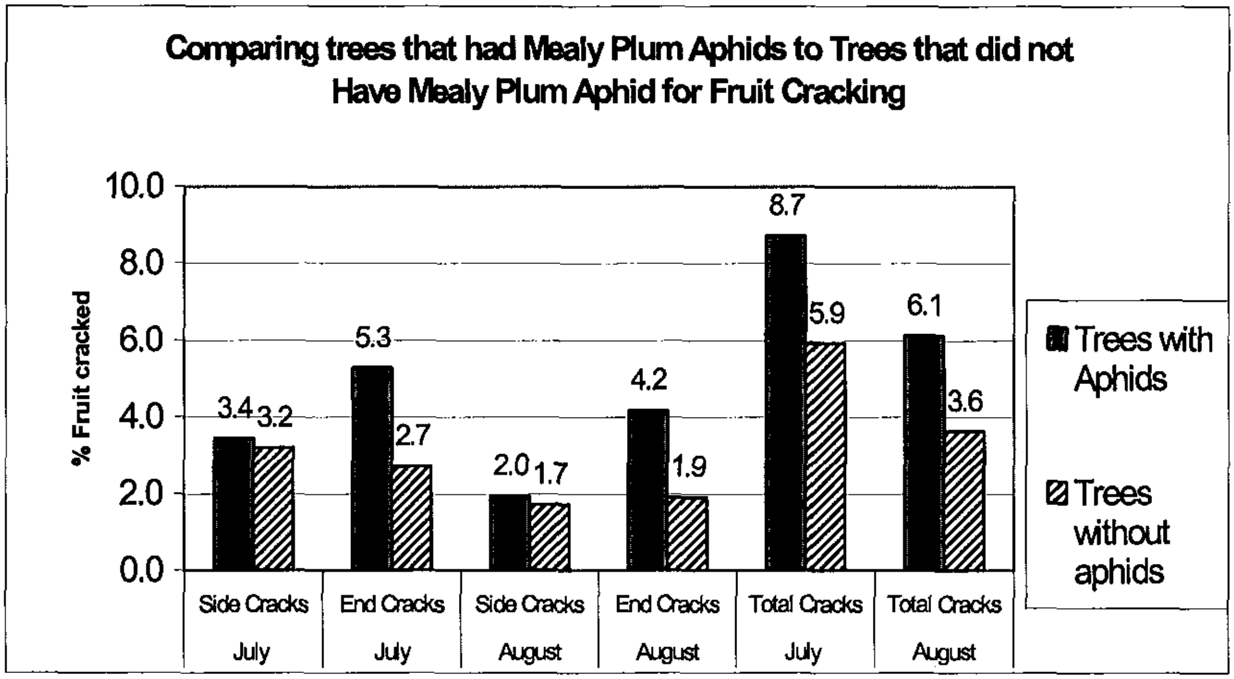


Fig8.

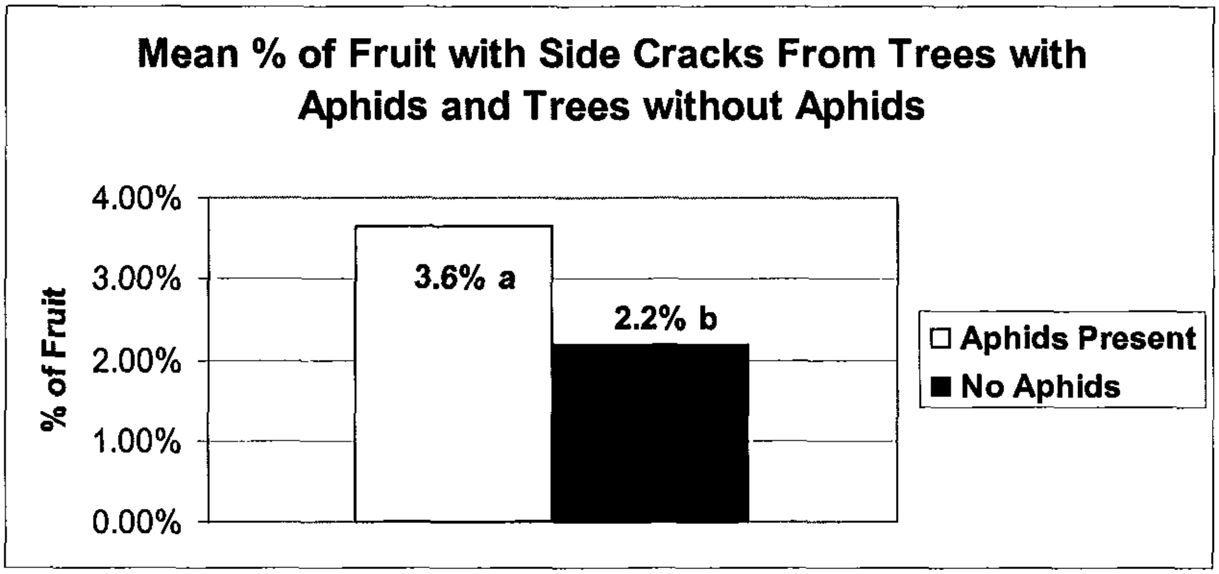
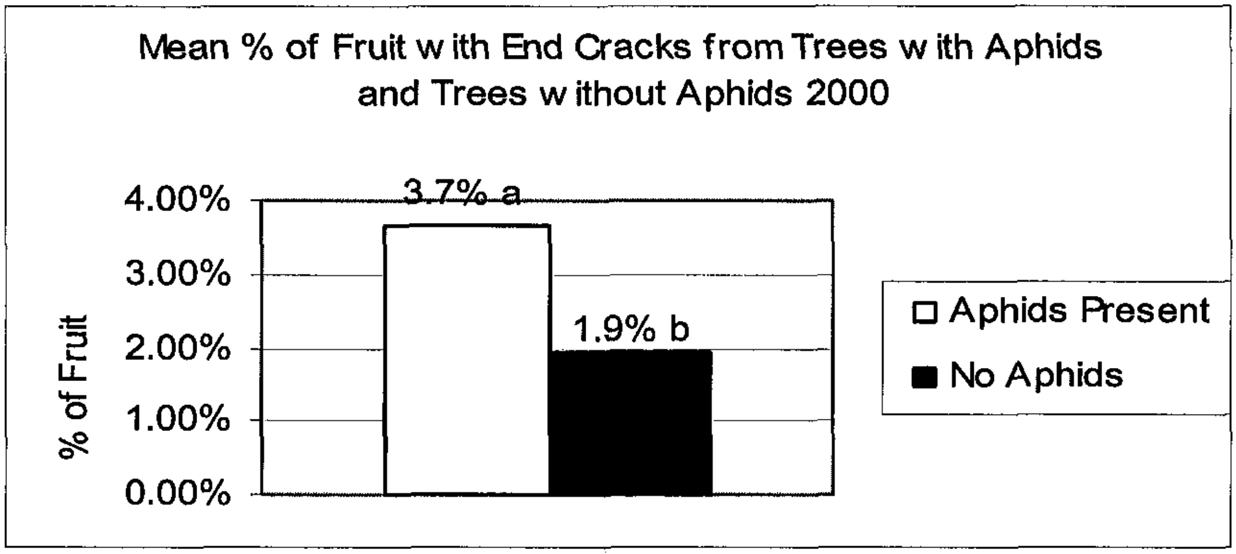


Fig9.



Treatment means that are not followed by a common letter are significantly different from each other at the 95% level of confidence according to Duncan's Multiple Range Test for Mean Separation.

Conclusion: The sequential sampling technique for aphids was just as accurate and much quicker than looking at all 80 trees. Using the new sequential sampling technique for presence of aphids gave us a good indication of when, and if, a treatment was needed. Only 8.7 percent of all orchards that did not receive a dormant spray needed a growing season insecticide treatment for aphids in 2001, compared to 42% of the orchards in 2000 and 45% in 1999. According to this information, a growing season aphid spray would have resulted in 235,554 lbs a.i. less pesticide being applied (based on applying Diazinon at the recommended label rate to all bearing prune acreage) in 2001. None of the comparison orchard's conventional plots, which received a dormant spray, needed a growing season spray in all three years. The treatment threshold (20 percent of significantly infested trees) appears to be fairly accurate. Harvest evaluations in 2001 did not statistically verify previous information that prune aphids cause fruit cracks. Many of the trees that had MPA did not have a significant aphid population (10 % or more of the tree infested with aphids). This may be the reason that there was no significant difference in fruit cracking in 2001. However, previous data from this project does show that aphids do cause fruit cracking (Figs 8 and 9). End cracks appear associated with aphids more than side cracks.

Over the next few years, surveys of growers will be conducted to determine the extent, if any, of implementation of the sequential aphid monitoring technique

4. Prune Rust Monitoring and Treatment Timing Recommendations:

Situation: Rust control is the most common pest treated during the growing season. Growers currently have no way to monitor prune rust. Most growers simply apply one or more protective wettable sulfur treatments in May, June and/or July following rain.

Previous research has shown rust treatments applied close to onset of rust infection are most beneficial and provide protection for about two weeks. Teviotdale and Sibbett have shown that post harvest defoliation from rust has no influence on subsequent fruit quality or productivity. In 1997 Olson, Krueger, and Teviotdale reported the appearance of rust infection on leaves has no influence on fruit soluble solids, dry away, size, etc. Fruit soluble solids, dry away, size, etc. can be affected if rust causes defoliation prior to harvest.

Evaluation: Since the beginning of this project forty orchard trees in each plot of each site were selected for monitoring. Monitoring for rust was initiated May 1st and continued every week in the Sacramento Valley and every other week in the San Joaquin Valley until mid-July if no rust was found. If rust was found, monitoring continued until approximately 4 weeks prior to harvest. Once rust was detected, a treatment was recommended. After a rust treatment was applied, and continued monitoring indicated an increase in rust, additional treatments were recommended.

Results: Fifty percent of the comparison orchards had rust and thirty-three percent of the demonstration orchards had rust in 2001. A determination of defoliation near harvest revealed none of those orchards had any defoliation due to rust in 2001 or 2000 (Figs 10 and 11). The orchard that had the longest interval between discovery of rust and harvest in 2001, 7 weeks prior to harvest, resulted in no defoliation by harvest time (Fig 10). In 2000, rust was discovered 6 weeks prior to harvest with no defoliation by harvest time (Fig 11). However, in 1999 there was some defoliation due to rust at harvest when rust was discovered 4 weeks prior to harvest (Fig 12).

Fig10.

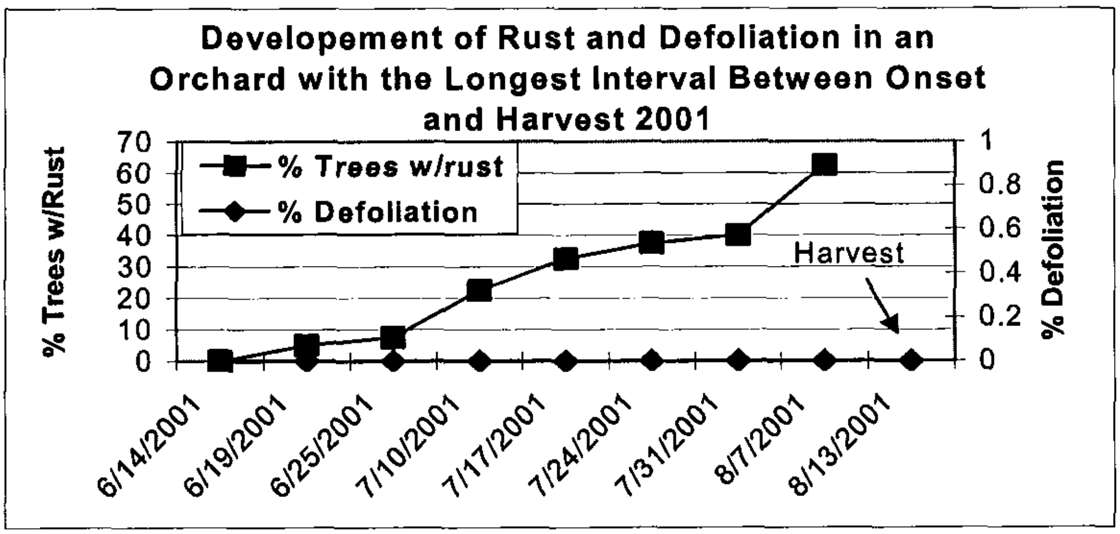


Fig11.

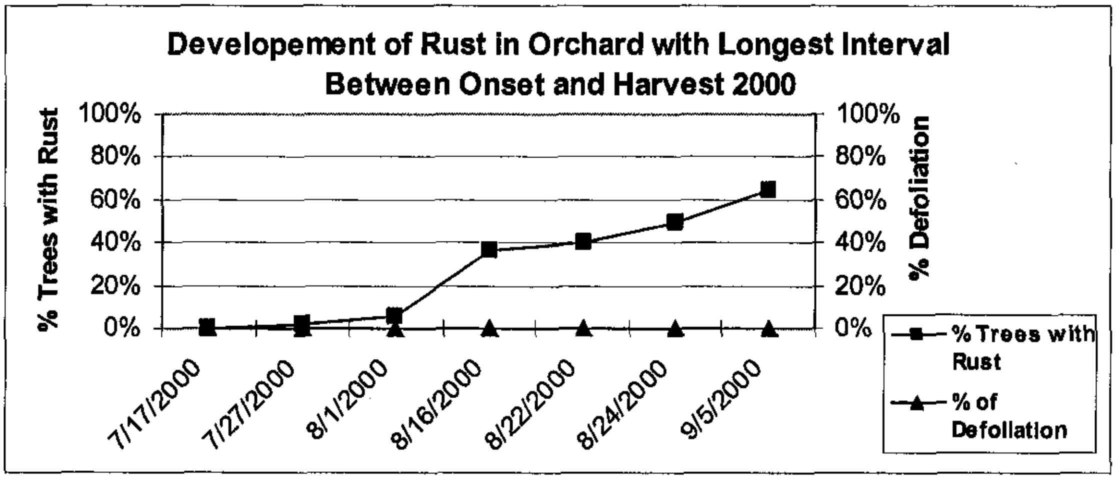
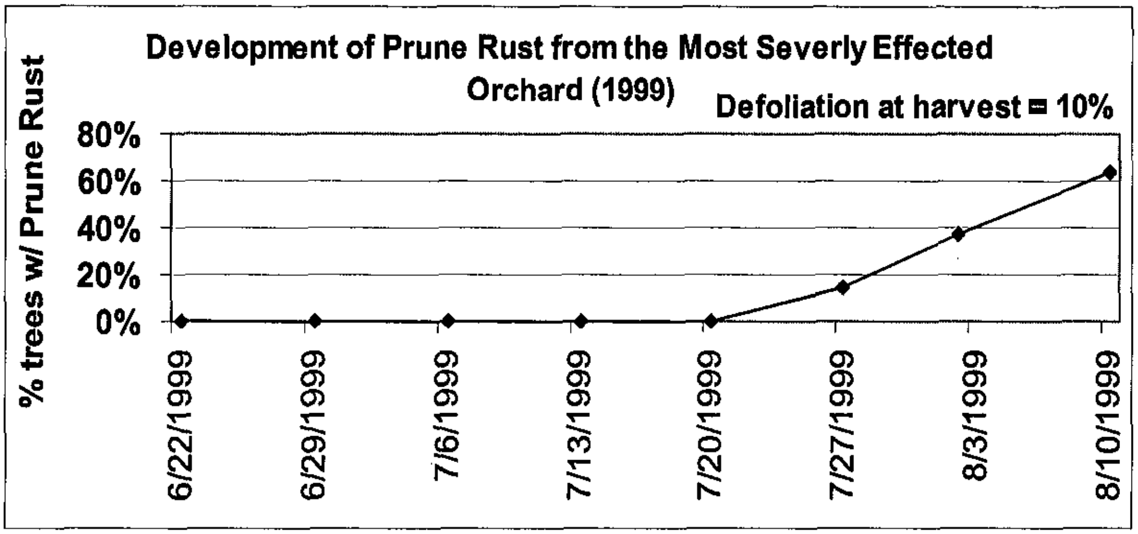


Fig12.



Conclusion: Monitoring prune rust is a fairly simple technique. It takes one person less than 30 minutes to evaluate an orchard. In 1999 only one orchard had 10 percent defoliation from rust and that was when rust was detected five weeks before harvest. In 2000, no defoliation from rust occurred when rust was detected six weeks from harvest. This past year no defoliation from rust occurred even when rust was detected seven weeks from harvest. This suggests that rust monitoring and rust treatments can be eliminated 4-6 weeks before harvest. In coming years, eliminating rust treatments at 5 or more weeks prior to harvest will be evaluated.

This monitoring technique has the potential of greatly reducing rust treatments. Ninety-one percent of all orchards monitored this year (2001) had either no rust or rust was found only after rust was no longer a potential problem (4 weeks prior to harvest). Nine Percent of the orchards had rust before the harvest treatment deadline of 4 weeks prior to harvest, but chose not to apply a treatment due to projected poor crop revenues this year. No orchard had defoliation due to rust. Had all prune growers followed this rust monitoring program in 2001 it would have reduced 1,565,200 pounds of pesticide (based on all bearing prune acreage receiving 1 sulfur application for rust at 20 lbs/acre) applied.

Over the next few years, grower surveys will be conducted to determine implementation extent of the rust monitoring technique for treatment need and timing.

5. Presence–Absence Sequential Sampling for Web spinning Mites:

Situation: Prunes are occasionally infested by web-spinning mites and require an in-season treatment. There are no established treatment thresholds for web-spinning mites in prunes, so the treatment threshold for almonds was used. Pest control advisors use subjective judgment when determining need for mite treatment that is difficult to document and teach growers. When growers make their own treatment decisions it is generally based on visible damage or on calendar date. This is often too late, too early, or unneeded. A presence-absence web-spinning mite monitoring technique was developed for almonds and is being validated for prunes.

Evaluation: In 1999, the presence-absence sequential sampling for web-spinning mites consisted of sampling 15 leaves from 10 trees per plot for presence of web-spinning and beneficial mites/predators. Sampling began around June 1 and continued for 10 weeks. Since 2000 the number of trees monitored dropped from 10 to 5 per plot due to the length of time it takes to complete monitoring. The treatment threshold was established when over 53 percent of the leaves had web-spinning mites or eggs with mite predators present, or 32 percent of the leaves have web-spinning mites/eggs with no predators present. Sampling took 30 – 45 minutes (5 trees per plot) and was done every other week until 20 percent of the leaves had mites. Once this level was reached sampling was done weekly.

Results: Monitoring showed a progressive buildup of mites and decline of predators in 2001 and 2000 (Figs 13 and 14). Trees with no defoliation averaged slightly higher soluble solids than trees with defoliation; however there was no statistical difference between them (data not shown). There was no statistical difference between web-spinning mite populations or mite predator populations in the orchards with reduced risk, conventional, and check plots (data not shown) from 1999 to 2001.

Fig13.

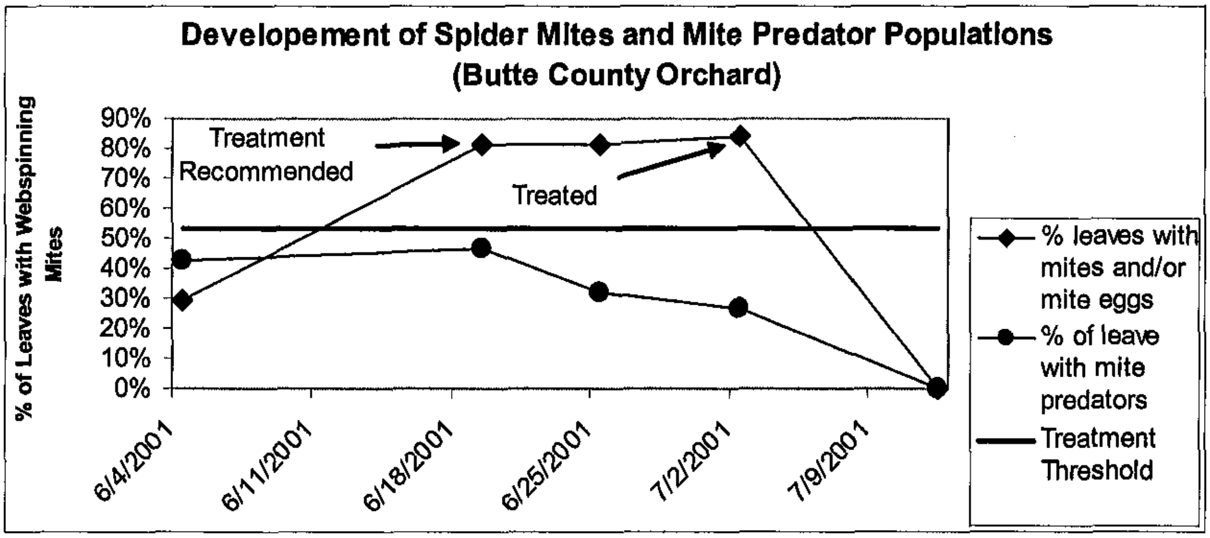
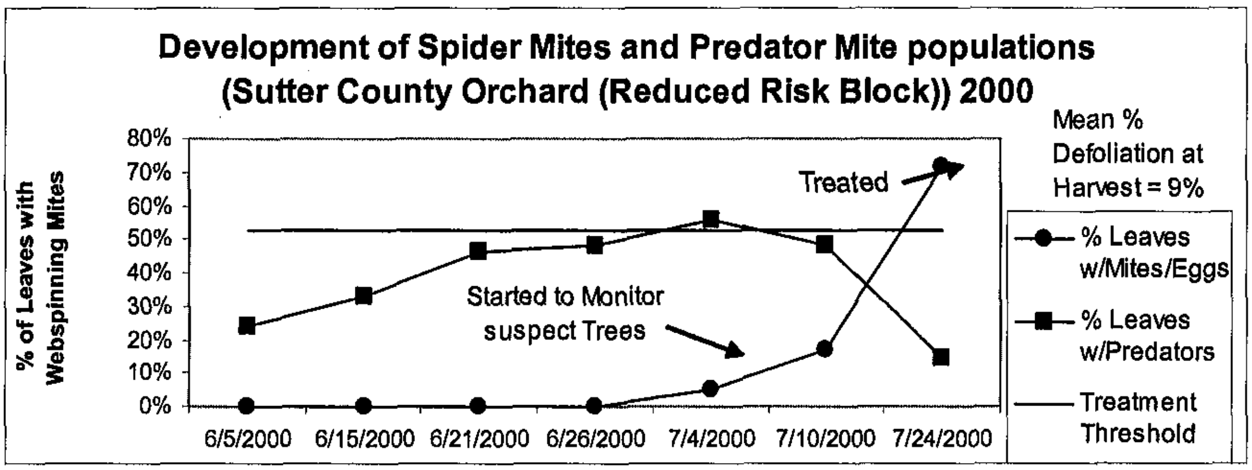


Fig14.



Conclusion: The presence/absence sequential sampling mite monitoring technique for prunes started in 1999 with scouts monitoring a minimum of 10 trees before a decision could be made. By 2000 the technique was refined to allow a minimum of only 5 trees be monitored before a decision could be made. With an average of only three- percent defoliation and no measurable difference in fruit soluble solids over the past three years, 53 percent of the leaves with mites/eggs and predators may be the correct treatment threshold for prunes Waiting until June to begin monitoring and waiting until 20% of the leaves had mites before increasing to a weekly sample appears too long an interval. Next season, monitoring will begin in mid-May and weekly monitoring will begin at a lower level of mite infestation.

Further evaluation of the treatment threshold will take place as more orchards have mites with defoliation at harvest. Although this monitoring technique takes too long for pest control advisors to implement the presence-absence monitoring technique for mites is a useful method of determining the need for treatment and reduces the likelihood of treating without justification.

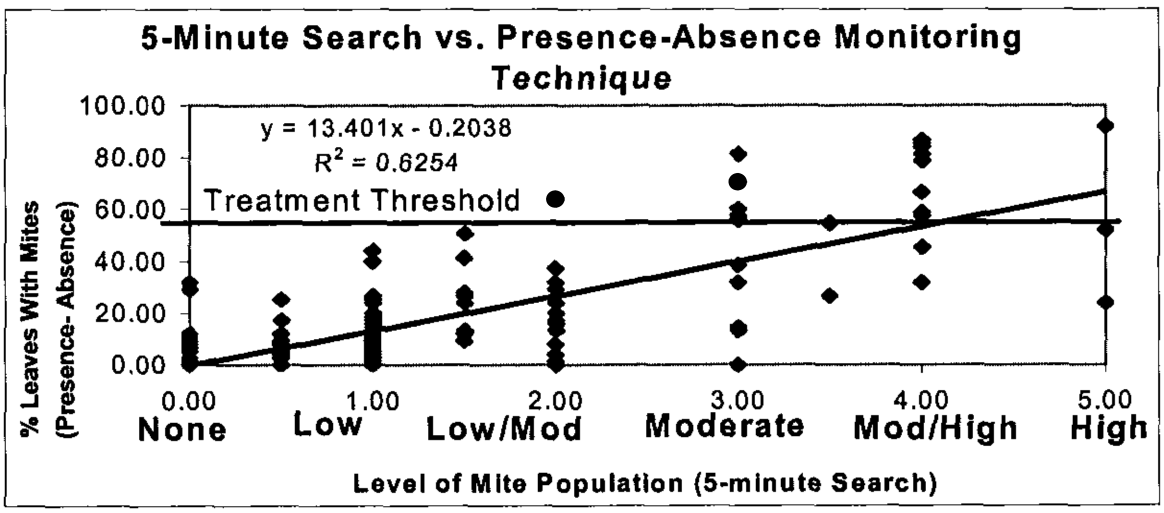
6. 5-Minute Search for Web spinning Mites Technique

Situation: The presence-absence sampling technique for web spinning mites is a useful method of determining need for treatment and reduces likelihood of treating without justification. However, very few pest control advisors will use this technique because it is to time consuming. A "5-minute search" monitoring technique, similar to what PCA's use, was evaluated in 2001 and results compared with presence-absence technique to determine if any correlation between the two could be made. No treatment decisions were made based on the new technique this past year.

Evaluation: The "5-minute search" monitoring technique for web spinning mites was performed in the same area of the orchard as the presence-absence technique, but the "5-minute search" was conducted first so that scouts would not be influenced results of the presence/absence technique. The new monitoring technique involved looking for symptoms of web spinning mites, as well as, looking at individual leaves with a hand lens to evaluate mite predator and web spinning mite populations. This would be done for approximately 5 minutes in two different locations in the orchard. After each 5-minute search, web spinning mite and mite predator levels were recorded. There were 6 categories for web spinning mites (none, low, low/moderate, moderate, moderate/high, high) and 3 categories for mite predators (low, moderate, high).

Results: The "5-minute search" monitoring technique had a 63% correlation (significant at the 99% level) with the presence-absence sampling technique in 2001 (Fig 15).

Fig15.



Conclusion: The "5-minute search" monitoring technique could be an accurate time saving monitoring technique to determine weather or not a treatment is needed for web spinning mites. The "5-minute search" requires more training and experience than presence-absence. One of the reasons that the correlation is not better was human judgment. One person's "low" could be considered another person's moderate. In order to reduce this variability, guidelines will be needed to define what exactly low, moderate, etc are. Training people scouting orchards will be more extensive next year. The correlation line suggests that the "moderate/high) level is the treatment threshold. However "moderate" would be a better treatment threshold because it is the first level that has numerous data points above the validated treatment threshold. More research comparing these two monitoring techniques will need to be done in order to establish more accurate treatment thresholds.

7. Fruit Brown Rot Predictive Model (ONFIT):

Situation: There is currently no way of knowing if fruit brown rot will occur. Consequently growers have been spraying pre-harvest for fruit brown rot based on a suspicion that it will occur. UC Plant Pathologist Themis Michalaides has created a technique to determine presence of fruit brown rot from latent infections that needs to be validated. The technique is called Over Night Freezing/Incubation Technique (ONFIT).

Evaluation: ONFIT involves freezing a sample of green fruit in early June then allowing it to thaw to promote development of latent infections by *Monilinia fruticola* or *Monilinia laxa*. Levels of latent infection revealed using the ONFIT technique were correlated to levels of fruit brown rot infection that became visible in the field later in the season. This information was used to determine need to protect fruit from brown rot infection with a fungicide application.

Results: Results of the ONFIT procedure predicted that 52 percent of the sites in 2001 (Table 9), 21 percent in 2000 (Table 10) and 36 percent of the sites in 1999 (Table 11) had low levels of latent brown rot present. Based on ONFIT, no fungicide treatments for fruit brown rot were recommended for any of the sites. In July and again at harvest, 1000 fruit per plot were examined for presence of brown rot infection. Results of the final field evaluations at harvest indicted that fruit brown rot was present in low levels at 43 percent of the sites in 2001, 43 percent of the sites in 2000 and 18 percent of the sites in 1999. Eight of the ten sites that had brown rot were among the twelve predicted to have brown rot using the ONFIT procedure in 2001. In 2001 brown rot levels during July exceeded 1 % infection in 2 sites, while at harvest only one site exceeded 1% infected fruit (Table 18). No sites in 1999 and only one site in 2000 exceeded the 1% infected fruit level for brown rot at harvest.

Table 9. 2001 ONFIT results

County and Site	ONFIT Prediction (% Brown Rot)	% Brown Rot Present in July	% Brown Rot Present at Harvest
Ag - Tulare	0	0.0	0.0
BR - Glenn	1	0.0	0.2
DB - Butte	2	0.3	0.2
Br - Madera	0	0.0	0.0
GC - Sutter	8	0.0	0.0
CSUC - Butte	0	0.3	0.0
DC - Butte	8	0.2	0.0
Fl - Tehama	1	0.0	0.0
EG - Fresno	0	0.0	0.0
BJ - Butte	2	0.5	1.5
JH - Sutter	0	0.0	0.0
JC - Butte	1	0.7	0.5
JT - Yolo	0	0.0	0.0
KJ - Yuba	5	7.0	0.2
LF - Glenn	1	0.2	0.2
MK - Yuba	6	0.7	0.0
AR - Tehama	0	0.0	0.0
MJ - Sutter	2	1.7	0.0
OO - Butte	0	0.0	0.3
RBF - Tehama	0	0.0	0.2
TR - Sutter	0	0.0	0.2
DV - Tulare	0	0.0	0.0
WG - Glenn	1	0.0	0.7

Table 10. 2000 ONFIT Results

County and Site	% Infected Fruit or Clusters of Fruit			
	ONFIT Prediction	Brown Rot Present at Harvest		
	Reduced Risk	Reduced Risk	Conventional	Check
Sutter - MJ	0	0	0	0.1
Yuba - MK	0	0	0	0
Yuba - KJ	0	0.3	0.1	0
Sutter - GC	0	0.1		
Sutter - JH	0	0.1		
Butte - BJ(clan)	0	0		
Butte - Harkey	0	0	0	0
Sutter - DC	0	0.1	0	0
Butte - CSUC	0	0.2	0	0.3
Butte - DB	0	0.1		
Glenn - WG	0	0.1	0	0
Tehema - D.E.	0	0		
Tehema - R.B.F.	0	0	0	0
Tehema - Mo	1	0	0	0
Tehema - V.D.	0	0	0	0
Butte - Ons	3	0.1	0	0.1
Butte - K.L.	2	0		
Madera - Br	0	0	0	0
Fresno - Ak	0	0	0	0
Tulare - Ag	0	0	0	0
Sutter - JR.T.	1	0.1		
Glenn - M.B.	1	1.7	0.1	0.4
T.B. - Merced	0	0	0	0
Yolo - JT	0	0	0	0

Table 11. 1999 ONFIT Results

County and Site	ONFIT Prediction % BR	% Brown Rot Present at Harvest		
	ESPS	ESPS	CONV	CHECK
Butte - CS	0.0	0.2	0.0	0.0
Yuba - KJ	0.0	0.0	0.0	0.0
Yuba - MP	1.0	0.0	0.0	0.0
Butte - BJ	1.0	0.0	0.0	0.0
Sutter - MJ	0.0	0.0	0.0	0.0
Sutter - DC	0.0	0.0	0.0	0.0
Sutter - GC	1.0	0.0	0.0	0.0
Sutter - JH	0.0	0.0	0.0	0.0
Tehama - VM	0.0	0.0	0.0	0.0
Tehama - RB	0.0	0.0	0.0	0.0
Glenn - WG	0.0	0.1	0.0	0.0
Yolo - JT	0.0	0.0	0.0	0.0
Merced - GL	0.0	0.0	0.0	0.0
Merced - TB	0.0	0.0	0.0	0.0
Fresno - CB	0.0	0.0	0.0	0.0
Tulare - DA	0.0	0.5	0.0	0.0
Madera - ST	0.0	0.0	0.0	0.0
Glenn - B	1.0	0.0	0.0	0.0
Butte - OO	4.0	0.0	0.0	0.0
Tehama - FM	2.0	0.0	0.0	0.0
Tehama - SV	5.0	0.0	0.0	0.0
Sutter - TR	6.0	0.1	0.4	0.9

Conclusion: The ONFIT technique needs to be evaluated under more severe conditions before it can be relied upon. Under the current conditions of little or no fruit brown rot, the ONFIT test was 67 % accurate in predicting whether or not the orchard would have some level of brown rot in 2001. Although this % accuracy may seem low, it is surprisingly high for so little brown rot found at harvest. However in 2000 the % accuracy was only 12.5 % and in 1999 it was 4.5 %. This monitoring technique could provide valuable guidance about the need for a fruit brown rot spray. More research and evaluation of the ONFIT during years of higher brown rot will need to be conducted before any definite conclusions can be made.

II. More Effective Use of Fertilizers and Natural Resources

1. Using tissue analysis and water samples

Situation: Although tissue analysis has been recommended for many years it is an underutilized tool in determining fertilization needs. Water analyses are also valuable; some wells have nitrate nitrogen in their water. Knowledge of N content of the water could be used by growers to supplement conventional N fertilizer programs. For adoption of these monitoring tools, their utility needs to be documented and demonstrated to growers.

Evaluation: Plant tissue and water samples for each site for each project year were collected in July. Results from the samples were reported to growers for their consideration when making decisions on fertilizer applications in the reduced risk plots.

Results: Results of water analyses are shown in Table 12 and tissue analyses in Tables 13-15. By multiplying ppm of NO_3-N by 2.72 you obtain lbs of N/acre ft of water applied. Sites highlighted in Table 10 have a high amount of NO_3-N in the water

Levels of Nitrogen, Potassium (K), Zinc (Zn) and Boron (B) were obtained through tissue analysis. Deficient levels of the nutrients are as follows: Nitrogen – less than 2.2 percent, Potassium – less than 1.3 percent, Zinc – less than 18 ppm, and Boron – less than 30 ppm. Boron is also toxic if the levels in the tissue exceed 100 ppm. Sites highlighted in Tables 13-15 indicate nutrient deficiencies.

Table 12. Water Analysis (1999-2001)

	2001		2000		1999	
Grower	NO3 - ppm	Lbs N/acre ft water	NO3 - ppm	Lbs N/acre ft water	NO3 - ppm	Lbs N/acre ft water
Ag - Tulare(north)	2.1	5.8	2.3	6.1	2.4	6.4
Ag - Tulare(south)	7.2	19.5	10.1	27.4	10.1	27.5
CSUC - Butte	4.8	13.1	3.2	8.6	5.7	15.5
D.B. - Butte	8.0	21.8	5.2	14.2		
D.E. - Tehama	1.7	4.6	1.7	4.5	6.1	16.5
Harkey - Butte	15.2	41.3	10.4	28.3	10.5	28.6
JH - Sutter	25.2	68.5	3.4	9.1	5.9	16.0
KJ - Yuba	1.2	3.3	1.6	4.4	1.7	4.7
MJ - Sutter	9.6	26.1	8.5	23.1	8.2	22.2
MK - Yuba	2.2	6.0	2.6	7.1	1.8	4.8
RBF - Tehama	0.8	2.2	2.7	7.4	2.1	5.7
DV - Tulare	3.6	9.7	2.1	5.7	2.1	5.7
EG - Fresno (BP)	3.9	10.6	8.3	22.6	5.2	14.1
EG - Fresno (RP)	8.2	22.3	<.05	<.135	<.05	0
Br - Madera	2.7	7.3	<.05	<.135	0.1	0.2
D.C. - Sutter/Butte			1.0	2.8	1.3	3.5
K.L. - Butte	0.7	1.9	1.5	4.2		
OO - Butte	0.2	0.5			<0.05	0
TR - Sutter	10.8	29.4			11	30
J.T. – Yolo			6.1	16.6	6	17

Table 13. 2001 Tissue Analyses for Various Nutrients

Grower	N -%	K - %	B - ppm	Zn - ppm
Ag - Tulare (Con)	2.34	2.36	62	14
Ag - Tulare(RR)	2.2	2.7	69	12
BR - Glenn	2.2	2.4	54	11
DB - Butte	1.7	2.6	59	60
Br - Madera	2.1	3.2	69	17
GC - Sutter	1.7	2.3	62	21
CSUC - Butte (CON)	2.3	2.4	49	21
CSUC - Butte (RR)	2.4	3.4	49	23
DC - Butte (CON)	1.9	3.0	52	23
DC - Butte (RR)	1.9	2.6	53	21
FI - Tehama	2.4	3.0	39	20
EG - Fresno (Con)	2.2	3.6	72	18
EG - Fresno (RR)	2.3	3.5	77	18
BJ - Butte (CON)	2.0	2.4	52	26
BJ - Butte (RR)	1.8	3.4	49	35
JH - Sutter	1.8	2.1	48	20
JT - Yolo (RR)	2.5	2.7	66	70
JT - Yolo (Con)	2.5	2.3	61	56
KJ - Yuba (CON)	2.5	2.2	51	24
KJ - Yuba (RR)	2.3	2.1	52	21
JC - Butte	2.1	2.7	58	19
LF - Glenn	2.0	2.5	59	18
MK - Yuba	2.0	2.1	39	18
AR - Tehama(Con)	2.6	4.4	76	20
AR - Tehama (RR)	2.4	3.4	72	18
MJ - Sutter (CON)	2.0	2.4	54	16
MJ - Sutter (RR)	2.0	2.9	57	16
OO - Butte	2.3	3.0	52	24
RBF - Tehama (Con)	2.8	4.1	91	38
RBF - Tehama (RR)	2.8	4.3	88	24
TR - Sutter	2.2	2.4	46	18
DV - Tulare (Con)	2.4	2.9	69	15
DV - Tulare (RR)	2.0	3.2	65	16

Table 14. 2000 Leaf Tissue Analysis

Grower/Orchard - County	N - %	K- %	B ppm	Zn ppm
D.E. - Tehama	3.0	4.0	51	23
K.L.- Butte	2.7	2.7	61	24
JR. T. - Sutter	2.7	2.8	47	20
J.H. - Sutter	2.4	2.5	50	13
Ons - Butte	2.5	3.1	58	19
B.J.(clan) - Butte	2.6	2.3	44	21
M.K. - Yuba	2.3	1.6	31	14
G.C. - Sutter	1.9	1.8	33	13
K.J. - (Reduced Risk)	2.4	1.2	35	23
K.J. - (conv.)	2.5	1.2	34	19
M.B. - Glenn	1.9	1.9	47	17
D.B. - Butte	2.3	1.9	46	14
CSU (Reduced Risk) - Butte	2.6	2.1	49	17
CSU (conv.) - Butte	2.6	2.7	52	19
Harkey (Reduced Risk) - Butte	2.5	1.8	40	13
Harkey (Conv.) - Butte	2.3	1.9	39	12
M.J. (conv.) - Sutter	2.4	1.6	43	11
M.J.(Reduced Risk) - Sutter	2.3	1.8	37	13
D.C. (Reduced Risk) - Sutter	2.4	1.4	37	14
D.C. (conv.) - Sutter	2.1	1.4	38	13
V.D. - Tehama	2.6	3.9	80	13
Mo. - Tehama	2.8	3.6	81	16
R.B.F. - Tehama	2.5	4.0	111	203
Br. - Madera	2.4	3.8	76	30
Ak (Con) - Fresno	2.8	3.4	81	137
Ak (Reduced Risk) - Fresno	2.4	3.9	87	185
DA (Conv) - Tulare	2.6	3.0	84	73
DA (Reduced Risk) - Tulare	2.7	3.2	70	69
DA (Check) - Tulare	2.6	2.5	67	30
J. T. (Reduced Risk) - Yolo	2.6	2.2	53	57
J. T. (conv) - Yolo	2.9	2.2	55	62
W.G. (Reduced Risk) - Glenn	2.2	2.8	47	25
W.G. (Conv) - Glenn	2.4	3.0	50	309
W.G. (Check) - Glenn	2.1	2.8	49	18
T.B. (Conv) - Merced	2.6	2.3	52	9
T.B. (Reduced Risk) - Merced	2.4	2.6	52	13
Gr. (Reduced Risk) - Merced	2.6	2.1	66	12

Gr. (Conv) - Merced	2.7	1.8	56	13

Table 15. 1999 Leaf Tissue Analysis

County & ID	Treatment	N-Total (%)	K-Total (%)	B (ppm)	Zn (ppm)
Butte-BJ	Conv.	2.3	2.3	44	178
Butte-BJ	ESPS	2.2	2.2	44	160
Butte-CSUC	Overall	2.6	3.2	66	27
Butte-OO	Overall	2.0	3.6	60	22
Glenn-B	Overall	2.5	3.4	71	165
Glenn-WG	Conv.	2.6	3.6	58	93
Glenn-WG	ESPS	2.3	2.7	54	36
Merced-GL	Conv.	2.9	2.2	66	21
Merced-GL	ESPS	2.5	3.2	80	17
Merced-TB	Conv.	2.4	2.7	47	17
Merced-TB	ESPS	2.7	2.1	55	182
Sutter-DC	Overall	2.3	2.3	48	18
Sutter-GC	Overall	2.2	2.5	52	19
Sutter-JH	Overall	2.4	2.3	45	16
Sutter-MJ	Overall	2.2	3.9	61	14
Sutter-TR	Overall	2.4	2.1	58	88
Tehama-F	Overall	2.2	4.1	46	20
Tehama-M	Conv.	2.4	2.9	73	263
Tehama-M	ESPS	2.6	2.5	73	26
Tehama-RB	Conv.	2.5	3.3	102	194
Tehama-RB	ESPS	2.7	3.4	106	231
Tehama-SV	Overall	2.7	3.7	71	231
Tulare-A	Conv.	2.6	3.2	59	70
Tulare-A	ESPS	2.5	2.3	51	33
Tulare-A	Check	2.5	2.0	57	30
Yolo-T	Conv.	3.4	1.8	46	51
Yolo-T	ESPS	2.5	2.2	51	50
Yolo-T	Check	2.5	2.1	52	47
Yuba- KJ	Overall	2.3	2.9	57	36
Yuba-M	Overall	2.2	3.4	47	18

Conclusion: Based on U.C. established critical mid-summer leaf tissue levels, almost half of the sites in 2001 were deficient in N. and a few sites had zinc levels below the recommended level. Nitrogen levels had declined since 1999. In 1999, 20 percent of the sites were N deficient, in 2000 five percent of the sites were N deficient and in 2001 48.5 percent of the sites were N deficient. The advisors involved at these sites will be worked with their cooperators to determine fertilizer strategies based on these data. Water samples did indicate several wells with significant levels of nitrate nitrogen. The high nitrate levels were considered when making fertilizer recommendations in the reduced risk plots. These tissue and water analysis have provided useful information and are proving to be valuable tools.

2. Early leaf analysis to forecast the need of a Potassium (K) fertilizer application:

Situation: Established guidelines for adequate leaf K levels in prunes are available using July leaf tissue samples. However, if a deficiency is present at that time, detrimental effects to production of the crop may have already occurred. Limited research has been done on using early leaf tissue samples to predict the need for potassium applications. This year (2001), the early leaf tissue sampling for K was compared to the July leaf sample in all of the research and implementation orchards.

Evaluation: One hundred fully expanded, mature leaves from at least 25 healthy trees were collected in the first week of May and tested for K content. Using previous research data, K fertilizer recommendations were used based on the May sample. The recommendations were: If over 2% there should be no need to apply K. If 1.5% to 2.0% leaf K is found, depending upon crop load, there may be no need to apply K. If 1.3% to 1.5% leaf K, observe tree appearance and crop load, and consider K applications to keep leaf K levels stable. If below 1.3 % K, then applications should be considered. The goal was to compare the early leaf K readings to the July leaf K readings in order to determine if you can predict leaf K status in July from early leaf K readings in May. By being able to predict K levels early on, fertilizers could be used to treat K deficiencies that would have a much larger detrimental effect later in the season.

Once in June, July and August, trees in the reduced risk and conventional plots were monitored for the presence of K deficiency symptoms.

Results: Based on the early leaf tissue samples taken in May, no fertilizer applications were recommended and no sites were found deficient in leaf K in July (Table 13). Also, no sites showed any visual symptoms of K deficiency in June. However, 2 sites in July and 11 sites in August had visual symptoms of K deficiency (Table 16).

Table 16.

Orchard	Leaf K May % K	Leaf K July % K	Visual Inspection Estimated % trees in the plot with K Deficiency Reduced Risk June	July	August
Ag - Tulare	2.7	2.7	0	0	0
BR - Glenn	2.2	2.4	0	0	0
DB - Butte	2.1	2.6	0	0	10
Br - Madera	3.5	3.2	0	0	0
GC - Sutter	2.1	2.3	0	0	20
DC - Butte	2.5	3.4	0	5	15
CSUC - Butte	2.3	2.6	0	0	60
FI - Tehama	2.9	3.0	0	0	0
EG - Fresno	3.8	3.5	0	0	0
BJ - Butte	1.9	3.4	0	0	15
JH - Sutter	2.7	2.1	0	0	5
JT - Yolo	2.5	2.7	0	0	0
KJ - Yuba	1.9	2.1	0	10	20
JC - Butte	2.0	2.7	0	0	10
LF - Glenn	2.5	2.5	0	0	10
MK - Yuba	1.8	2.1	0	0	25
AR - Tehama	2.6	3.4	0	0	0
MJ - Sutter	2.3	2.9	0	0	30
OO - Butte	2.3	3.0	0	0	0
RBF - Tehama	2.3	4.3	0	0	0
TR - Sutter	2.3	2.4	0	0	0
DV - Tulare	3.0	3.2	0	0	0

Conclusion: Results from this trial are inconclusive. July leaf K levels were very high this year (2001). More research will be needed in orchards that have deficient leaf K levels before any conclusions can be drawn.

3. Irrigation management:

Situation: Irrigation requirements of fully canopied orchards have been determined for stone fruits. It is generally assumed these requirements also apply to prunes. However, previous research has determined that reducing irrigation (typically 40%) in mid-season, allowing mild stress to occur has no economic effect on production and quality. In order to achieve the goal of reduced irrigation and maximum economic productivity, we utilized a monitoring technique that determines tree-water status (midday stem water potential or SWP) and evaluates stress. We determined the midday SWP by using a "pump up" pressure chamber. A plastic/foil envelope is used to cover a lower canopy leaf that is close to the trunk or a main scaffold. The bagged leaf must remain on the tree for at least 10 minutes. The bagged leaf is then placed in the chamber with only the petiole sticking out. Air is forced into the chamber by pumping the device up and down (similar to a tire pump) until water is forced out of the petiole. The amount of pressure that it took to force the water out of the leaf is measured in bars. The amount of bars it took to force the water out of the leaf is the tree's SWP.

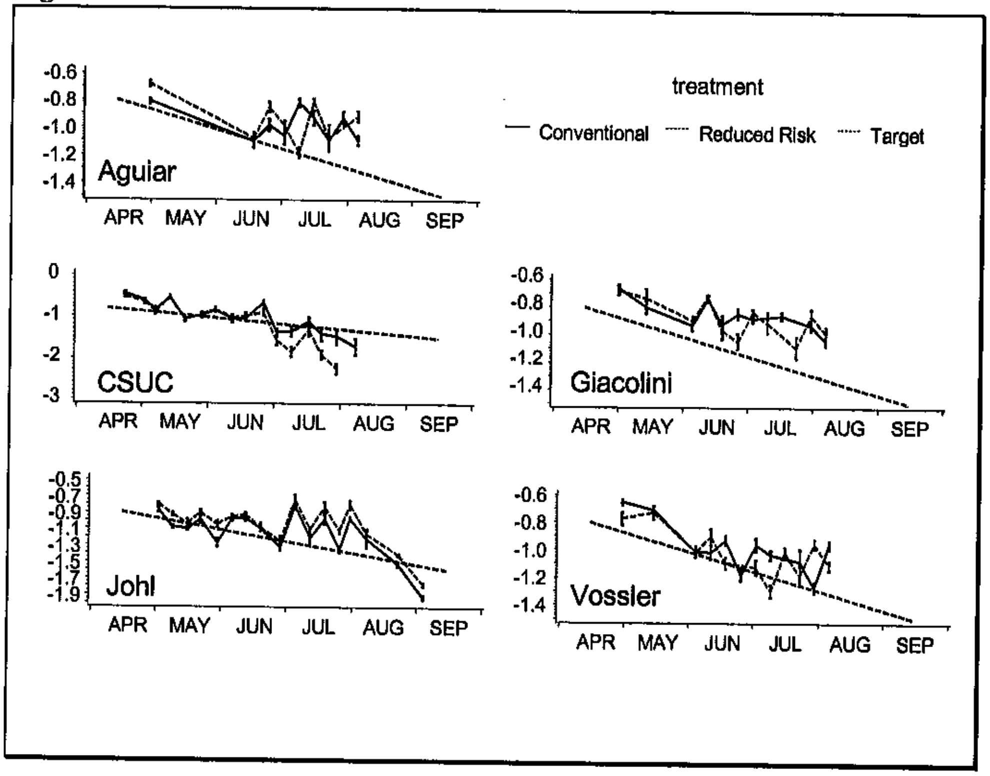
Evaluation: Based on results of 2001, recommended leaf--bagging duration was reduced to a minimum of 10 minutes, but recommended sampling time for SWP continued to be at midday, between 1:00 pm and 3:00 pm (daylight savings time). In most cases a sample of 10 trees were used for orchard monitoring approximately weekly. Irrigation was only recommended when SWP reached the target values as shown in table 8B.

Table 17. Reduced risk irrigation target values over the growing season for midday stem water potential (bars).

Period	Month						
	March	April	May	June	July	August	September
Early-	-6	-8	-9	-10	-12	-13	-14
Mid-	-7	-8	-9	-11	-12	-13	-15
Late-	-7	-9	-10	-11	-12	-14	-15

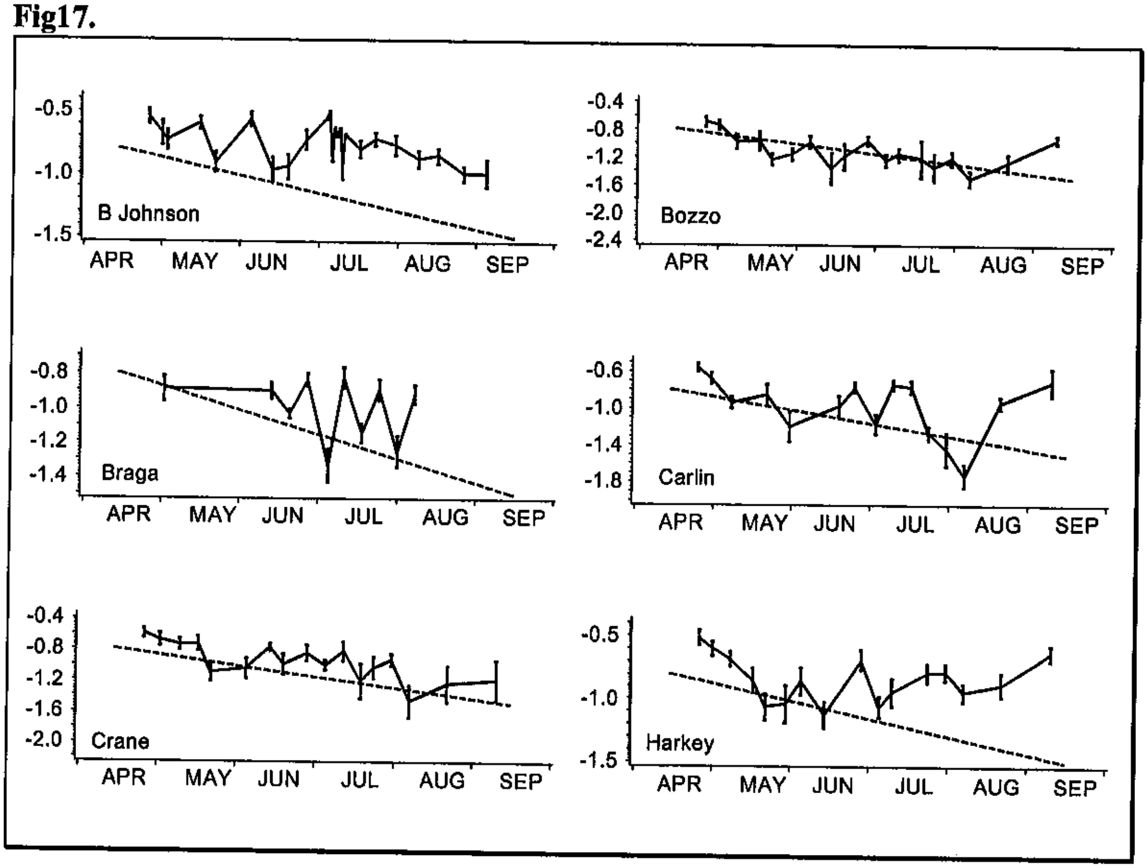
Results: Five of the sites have historically involved a comparison between conventional irrigation management and reduced risk irrigation management. At most of these sites however, growers are recognizing benefits of the reduced risk program, and have adopted a reduced risk approach to irrigation in the conventional blocks. As a result, there were only minor differences between these comparison treatments in the 2001 season, with SWP in both treatments approximating the recommended reduced risk SWP target values (Fig 16). For the other monitored sites we generally observed a good match between the observed and the target SWP, but there was some grower-to-grower variation (Figs 17 and 18).

Fig16.



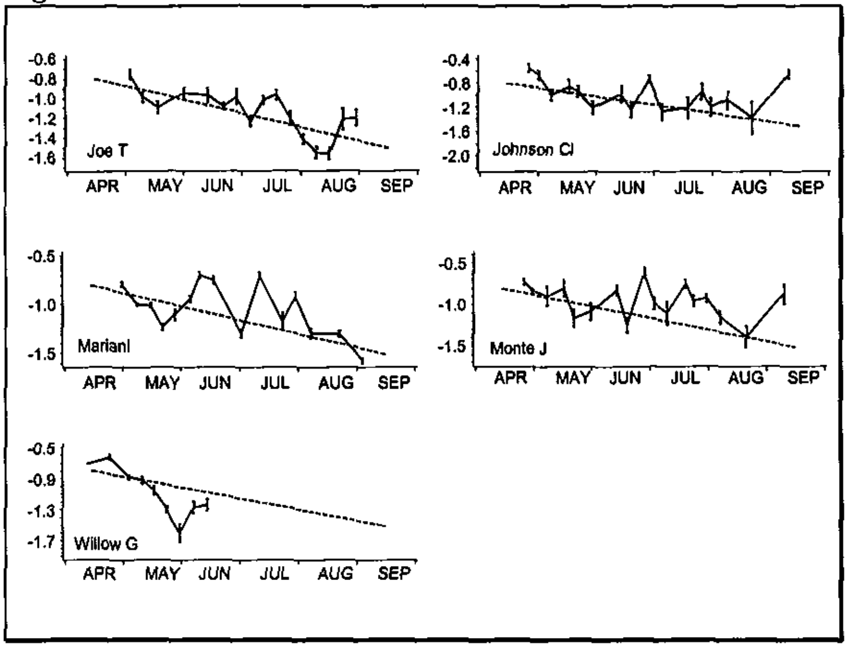
treatment
Conventional
Reduced Risk
Target
Aguiar
CSUC
Giacolini
Johl
Vossler
APR
MAY
JUN
JUL
AUG
SEP

Fig17.



B Johnson
Bozzo
Braga
Carlin
Crane
Harkey
APR
MAY
JUN
JUL
AUG
SEP

Fig18.



Conclusion: Most growers who began with comparison plots of reduced risk and conventional irrigation have adopted the reduced risk irrigation monitoring strategy on their conventional blocks, indicating they have recognized benefits of this approach to irrigation scheduling. Other growers have reported unanticipated horticultural benefits of this practice, for instance the suppression of an undesirable and often chlorotic flush of shoot growth in the fall, presumably the result of over-irrigation. The fact that many growers have matched the reduced risk target SWP over the season indicates that the reduced risk monitoring technique is practical and achievable over a range of soil and orchard conditions.

This part of the project has become increasingly popular with growers because using the pressure chamber to schedule irrigations can save potentially save them money by applying less water.

4. Quality and harvest evaluation:

In 1999 and 2000, quality data were obtained from growers' P-1 grade sheets. However, these grade sheets were difficult to obtain from the grower, made harvesting for the grower more complicated and lumped disease and insect data together. In 2001 the Dried Fruit Association (DFA) provided quality analysis from harvest samples taken from each plot. There were no significant differences between any of the treatments (Reduced Risk, Conventional, and Check) in soluble solids, dry count per pound or dry away ratio (Tables 18-20). In terms of quality, there were no significant differences between the Reduced Risk and Conventional plots for %ABC screen, total % ABC off-grade, % ABC off-grade due to cracks, splits, etc... or % ABC off-grade due to insects and/or disease (Tables 18-20).

Table 18.

Mean 2001 Harvest and Quality Data							
	S.S.	Dry Ct./ lb.	Dry Away Ratio	%ABC Screen	Total % ABC Offgrade	%ABC Offgrade due to Cracks/splits etc..	%ABC Offgrade due to disease/insects
Reduced Risk	23.9	62.7	2.9	81.0	7.2	5.5	0.5
Conventional	24.5	63.1	3.0	81.5	5.5	4.0	0.6
Check	23.5	55.3	2.8	87.4	8.4	6.3	0.5
		Ns	Ns	Ns	Ns	Ns	Ns

Table 19.

2000 P-1 Grade Sheet Analysis					
	Yield (lbs/acre)	Average Count per Pound	Dry Away	% ABC screen	% ABC Offgrade screen
Reduced Risk	4903.07	57.50	3.22	91.60	1.54
Conventional	5139.39	58.80	2.99	91.52	1.26
	Ns	Ns	Ns	Ns	Ns

Table 20.

1999 P-1 Grade Sheet Analysis					
	Yield (lbs/acre)	Average Count per Pound	Dry Away	% ABC screen	% ABC Offgrade screen
Reduced Risk	4705	52.5 b	2.8	91.4	2.2
Conventional	4387	54.8 a	2.8	90.1	1.1

Treatment means that are not followed by a common letter are significantly different from each other at the 95% level of confidence according to Duncan's Multiple Range Test for Mean Separation.

Conclusion: Based on data obtained from the 1999 and 2000 P-1 grade sheets, as well as 2001 quality data, no adverse affects have been seen in the reduced risk program as compared to the conventional program.

III. Encourage Known Useful Cultural Operations into a More Sustainable Farming System

Meetings to share information were numerous and well attended. Over 750 people in 2001, over 1,100 in 2000 and over 830 in 1999 received information at meetings on the IPFP project. Following is a list of meetings held, dates, and subjects covered (Tables 21-23):

Table 21. 2001 Educational Meetings

County	Date(s)	Subjects Covered
Butte/	4-6-01, 4-20-01, 5-3-01, 5-17-01, 6-13-01, 6-26-01, 12-6-01,	Cover Crops, reduce inputs for insect control, River Contamination, Irrigation Scheduling
Sutter	4-25-01, 5-17-01, 12-5-01	Prune Aphids, Reduced Risk overview, Cover Crops
Colusa	2-8-01	Cover Crops
Glenn	4-19-01, 5-24-01, 12-5-01	Vegetation to reduce dormant spray runoff, Cover Crops, Prune Aphids
Madera	4-5-01	Cover Crops
Tehama	3-6-01, 5-25-01	Reduced Risk overview
Tulare	2-27-01	Reduced Risk Overview
Sacramento	6-10-01	Dormant Spray Runoff

Table 22. 2000 Educational Meetings

County	Date(s)	Subjects Covered
Butte/ Sutter	10-12-99, 5-4-00, 2-22-00, 6-28-00 10-8-99, 5-12-00, 5-26-00	Cover Crops, reduce inputs for insect control, River Contamination, Prune Aphids, Reduced Risk overview
Colusa	4-27-00	Cover Crops
Glenn	11-15-99, 4-20-00, 6-16-00 4-20-00	Vegetation to reduce dormant spray runoff, Cover Crops, Prune Aphids
Merced	3-15, 4-5, 4-19, 5-3, 5-17 6-7, 6-21, 7-5-00	IPM updates
Tehama	10-6-99, 3-7-00,5-10-00	Cover crop planting, Reduced Risk overview
Tulare	6-13-00	Reduced Risk overview

Table 23. 1999 Educational Meetings

County	Date(s)	Subjects Covered
Butte/ Sutter	1/20, 3/4, 10/8, 10/10/99	Sprayer calibration, ESPS case history, ESPS overview, Aphid monitoring
Glenn	5/5/, 11/17/99	Vegetation to reduce dormant spray runoff, ESPS overview
Merced	Twice monthly during Spring and summer	Pest updates
Tehama	5/6/, 10/6/99	Cover crop planting, ESPS overview
Tulare	2/26/99	ESPS overview
Yolo	5/13/99	ESPS overview, prune aphids

In addition, the Tehama county advisor provided insect day degree accumulation to clientele via e-mail on a regular basis. Advisors also wrote several newsletters.

Pest control advisor involvement

Pest Control Advisors (PCA) were asked to review and if possible try using monitoring techniques under evaluation during the 2000 and 2001 seasons. At meetings held in October 2000 and spring 2001, the PCA's and the project team met and discussed the monitoring techniques. Following are highlight points made at those meetings:

1) Many of the monitoring techniques took too long to implement. Many PCA's reported that they could not spend more than one-hour per week in an orchard. One PCA said he could not spend more than 30 minutes in an orchard. Suggestions made to speed up the monitoring procedure included: using a timed search rather than looking at a certain number of trees, look at one side of tree only rather than walking around tree, rather than recording data just keep a mental note of abundance of the pest being monitored.
2) Several PCA's reported that they use a more subjective monitoring technique. The quantitative monitoring under evaluation takes too long.
3) The PCA's all agreed that the treatment thresholds were about right and about the same that they have been using.
4) Most PCA's found that the dormant spur sampling technique was useful and even though it took some time, the winter is when they have more time and it required monitoring only once per season.
5) The PCA's found that the tree and fruit monitoring technique were useful but agreed that it took too long and too many trees had to be looked at before a decision could be made.
6) PCA's felt that the springtime aphid monitoring technique was useful but preferred quickly covering the entire orchard rather than the quantitative approach as stated in the monitoring technique.
7) PCA's found that the pheromone traps provided little if any useful information and recommended

discontinuing their use.

Overall, the PCA's were pleased to be involved in the project. As stated in the highlighted points of the meeting, the PCA's favor more subjective methods of monitoring. However, for this project, quantitative methods must be used in order to determine what treatment threshold and/or monitoring techniques are the most accurate. When the techniques and thresholds are finally presented to all involved in the prune industry, it is understood that many will use subjective techniques and shortcuts in order to save time and money. Most of the PCA's at the meetings agreed to continue being involved in 2002.

Securing additional grant support:

Additional grant support was solicited and secured from several sources. Listed below are the sources of each additional grant that is being used to support this project:

CalEPA/DPR/PMA
UC/SAREP/BIFS
USDA/CSREES
USDA/NRCS
USEPA/Region 9

The new grants secured will allow this project to evolve in 2002 maintaining approximately the same number of field sites at 31 and increasing efforts towards technology transfer via newsletters, grower meetings, working with PCAs and measurements of impact of project on the industry. With the support of the California Prune Board and other sources of grant support, this work can continue to produce "reduced risk" pesticide and cultural options for prune producers.

Pesticide use reporting:

One of the main goals of the IPFP project that began in 1998 was to reduce the amounts of Organophosphate pesticides applied. Shown below, in Figs. 19 and 20, are pounds of active ingredient applied per acre to prunes from 1998 to 2000. Both Diazinon and Supracide have decreased since 1998, while Asana has remained almost the same (Fig 19). The amount of sulfur has decreased the most over the three years (Fig 20).

Fig19.

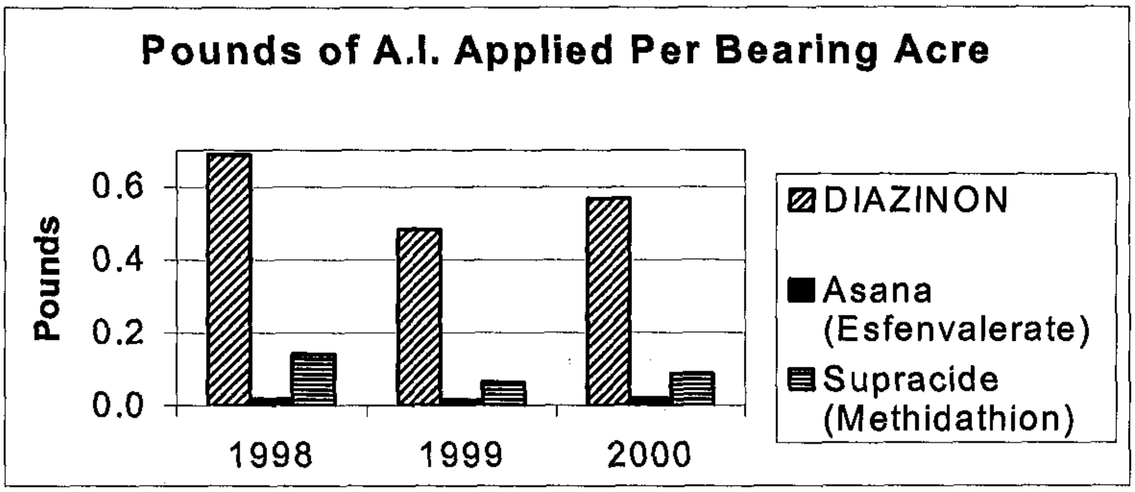
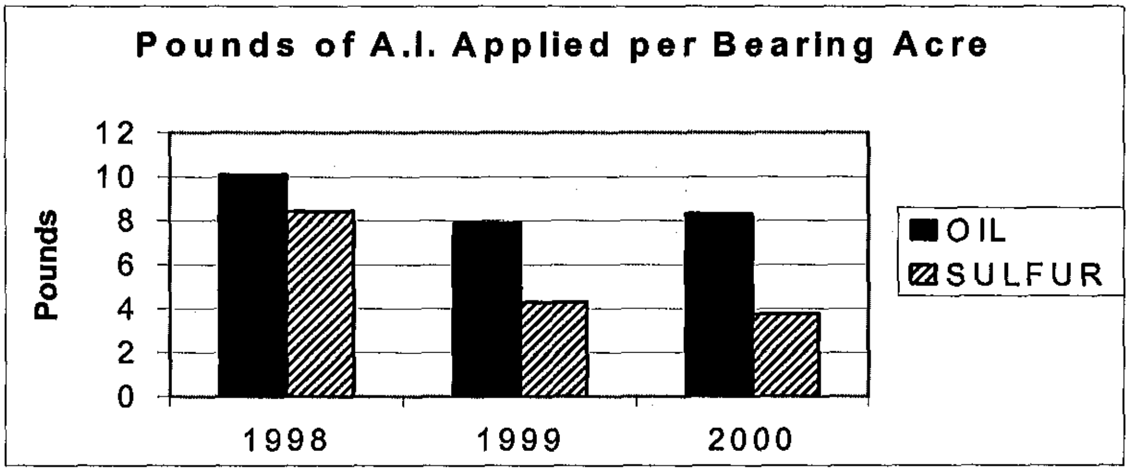


Fig20.



New directions in the IPFP project:

- Defoliation of the orchard early in the fall will be further evaluated as a control of Prune Aphids
- Reduced rates of Diazinon and Asana in a dormant application will be further evaluated for control of aphids.
- Pest control advisors (PCA's) will continue to be involved in the project by using the monitoring techniques in some demonstration plots.
- Some of the monitoring techniques will be modified so that they can be conducted faster and made more "PCA friendly."
- Within the next two years, have a "how to" workshop with a binder on monitoring pests, nutrients and irrigation.